TRANSACTIONS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II.

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PART II.

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TRANS-

TRANSACTIONS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. PART I.

HISTORY OF THE SOCIETY.

HISTORY

OF

THE SOCIETY.

LITERARY *Class.* Mr DALZEL read a Philological Dissertation on certain Analogies observed by the Greeks in the use of their Letters; and particularly of the Letter Σ; which is printed in this volume. [No. IV. *Lit. Cl.*] 1785. Dec. 19. Mr Dalzel on the Greek Σ.

Physical Class. THE Secretary read a Letter to the Society, from the Reverend Dr ROBERTSON, inclosing one from Mr FRASER, Under-secretary of State, and one from M. ANISSON of Paris, with a Memoir on the subject of Printing. 1786. Jan. 2. Memoir on printing.

Lit. Cl. Dr GREGORY read a continuation of his Essay on the general Notion of the Relation of Cause and Effect. [See Vol. I. Hist. Nov. 15. 1784. and March 21. 1785.] Jan. 16. Dr Gregory on cause and effect.

1786.
Jan. 23.
General Meeting.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See Vol. I. Appendix to the Hiſtory of the Society.]

Feb. 7.
Dr Home on Amauroſis.

Phyſ. Cl. Dr FRANCIS HOME read a paper on *Amauroſis*.

Dr Small's demonſtrations of Dr Stewart's theorems.

THE Reverend Dr SMALL read the Heads of a paper containing Demonſtrations of twenty-eight of the Theorems publiſhed in 1746, by the late Reverend Dr MATTHEW STEWART, Profeſſor of Mathematics in the Univerſity of Edinburgh. The Demonſtrations are printed in this volume. [No. XII. *Phyſ. Cl.*]

Feb. 20.
Prof. Young on the Greek middle voice.

Lit. Cl. Mr DALZEL, one of the Secretaries, read part of an Eſſay on the Middle Voice of the Greek Verb, written by Profeſſor JOHN YOUNG, of the Univerſity of Glaſgow. On account of ſome additions intended to be made by the Author, the publication of this Eſſay is poſtponed to a ſubſequent volume of the Tranſactions.

March 6.
Mr Robiſon on the Georgium Sidus.

Phyſ. Cl. Mr Profeſſor ROBISON read a paper on the Orbit and Motion of the new Planet, the *Georgium Sidus*; which is printed in the firſt volume of the Tranſactions of this Society. [Vol. I. No. XI. *Phyſ. Cl.*]

March 20.
Dr Macfarlan on the land-tax.

Lit. Cl. THE Reverend Dr MACFARLAN read a Diſſertation reſpecting an equal Aſſeſſment of the Land-tax.

Prof. Young on the Greek middle voice.

Mr DALZEL read a continuation of Mr Profeſſor YOUNG's Eſſay on the Middle Voice of the Greek Verb. [See *ſupra*, Feb. 20.]

April 3.
Mr Playfair's life of Dr Matthew Stewart.

Phyſ. Cl. The Reverend Mr Profeſſor PLAYFAIR read an Account of the Life and Writings of the late Reverend Dr MATTHEW STEWART, Profeſſor of Mathematics in the Univerſity

of

of Edinburgh. This Account is publiſhed in the firſt volume of the Tranſactions of this Society. [Hiſtory of the Society, Appendix.] 1786.

April 3. Dr Anderſon on the culture of potatoes.

Dr JAMES ANDERSON read an Eſſay, containing Obſervations and Experiments on the Culture of Potatoes. He did not chuſe that any abſtract of this Eſſay ſhould be publiſhed.

Books preſented to the Society.

THE Secretary preſented to the Society two books, one in Latin, *De Herpete*, and the other in French, *Sur la Petite Verole*, written by M. ROUSSEL, Royal Profeſſor of Medicine in the Univerſity of Caen in Normandy, ſent by him to the Royal Society of Edinburgh.

April 17. Prof. Young on the Greek middle voice.

Lit. Cl. Mr DALZEL read the remainder of Mr Profeſſor YOUNG's Eſſay on the Greek Middle Voice. [See *ſupra*, March 20.]

June 19. Dr Hutton on written language.

Dr HUTTON read part of a Diſſertation on Written Language as a Sign of Speech.

IT is the purpoſe of this paper to ſhow, in what manner we arrive at the knowledge of ſimple ſounds, by the analytical examination of our ſpeech, or the reſolution of it into its principles. Theſe ſimple ſounds may be repreſented to the ſight, by means of certain figures, appropriated to thoſe ſounds. Such figures then become the principles, *firſt*, of the writing of our ſpeech, and, *2dly*, of the reading of our written language.

THERE being no leſs than four different methods of analyſing ſpeech for the purpoſe of typifying language, theſe are examined with a view to underſtand the advantages and diſadvantages that may attend each of thoſe particular methods, according to the following order: *firſt*, The analyſing of ſpeech into parts, each of which is the ſign of a diſtinct thought; *2dly*, into words, the conſtituent parts of our expreſſed thoughts;

3dly,

3dly, into ſyllables, or articulate ſounds, the conſtituent parts of words; and, *laſtly*, into letters, or inarticulate ſounds, the conſtituent parts of ſyllables.

There are only two of thoſe practicable methods of typifying ſpeech, that have any peculiar advantage to recommend their uſe. Theſe are the verbal method, on the one hand, and the elemental, on the other. Each of theſe having their peculiar advantages, are now to be mentioned.

The advantages of the verbal method conſiſt in this, that different nations, by this means, might communicate their deſires by writing, without the knowledge of each other's ſpeech. But the neceſſary diſadvantage of this method is more than ſufficient to counterbalance its great benefit; becauſe, while there would not be ſufficient accuracy for thus expreſſing every thought in writing, it would require to make it the buſineſs of a man's life to read and write. Whereas the advantage of the elemental method will appear from this, that while the commutation of our figures and our ſimple ſounds is perfect, our ſpeech, which is compoſed of thoſe ſimple ſounds, may be written with facility, and our written language read with abſolute perfection. The benefit of this method, therefore, far more than compenſates for its loſs, in not ſerving as a mean of correſpondence between foreign nations.

Music and ſpeech are next conſidered, in order to ſee their neceſſary connection and the difference of their principles.

The formation of articulate expreſſion, by means of vocal ſounds and conſonants, is then illuſtrated, in ſhewing the nature of our ſpeech, as the foundation of our art of writing.

Thus, an alphabet is repreſented as being the work of ingenuity and wiſdom, and as being, with good reaſon, the boaſt of ſcience. The corruption, therefore, of this alphabetical method of characteriſing ſpeech, is reprobated as an error prejudicial to ſcience, and diſgraceful to a nation that is wiſe and learned.

Orthography

Orthography being thus a moſt ſcientific art, it is of much importance, for the educating of a people in this art, to conform the practice ſtrictly to the rules of ſcience, and to have the rules of that ſcience compriſed in the knowledge of the alphabet. The alphabet is therefore now made the ſubject of a ſcientifical diſcuſſion.

An alphabet being nothing but the figured elements of ſpeech, and ſpeech conſiſting of articulated ſounds, we are to examine thoſe diſtinct ſounds which man has it in his power to form for the purpoſe of his ſpeech, and alſo all the practicable articulations proper for modifying his vocal ſounds.

The vocal power of man is, from experience, found to be divided into ſeven diſtinct notes, and this power is repreſented by a line divided into ſix equal parts, which forms ſeven equal diſtinctions of his perfect ſounds.

The letter *i* is here affixed to the moſt acute or higheſt of thoſe notes of vocal ſound, and *u* is the written ſign affixed to the loweſt, *or* the note which is naturally moſt grave. In a middle place between thoſe two extremes, in this vocal capacity of man, is placed the ſound, which is conſidered as correſponding to the letter *a.*

Thus, we have the radical alphabet, of the perfect vocal ſound in the letters *i*, *a*, *u*. All the other ſounds are then neceſſarily comprehended between that middle vowel and the two extremes. This determined ſpace of vocal ſound is then ſubdivided, the upper half, or higheſt ſpace, into the vowels *e* and *η*, the lower, again, into thoſe of *o* and *υ*.

Thus we complete the ſeven perfect notes of human voice or vocal ſounds; and theſe are all defined or diſtinguiſhed, in deſcribing the gradual change or regular modification of the organ, which is neceſſary in ſounding each.

But beſides the ſeven perfect vowels which compoſe what may be termed the radical alphabet of human ſpeech, there are two ſemitones, placed ſomewhere between the middle note,

and thoſe on each extreme. This is exemplified in the uſe of ſpeech; although hitherto no letter has been contrived for thoſe two diſtinctions of our voice, which are found in the words *this* and *thus*.

THE vocal powers of man being thus determined by nature, and defined in ſcience, it is neceſſary, in order to complete the alphabet, to have the various articulators of the vocal ſound examined, with a view to ſee how far all the organical powers of man have been practiſed for the purpoſe of his ſpeech, and alſo to underſtand the nature of thoſe improper articulators which may be occaſionally employed.

As the diſtinctions in the vocal ſound of man are ſo limited, and as the ideas to be expreſſed in his ſpeech are ſo multifarious, it is neceſſary to compound thoſe diſtinct ſounds by means of articulations, which are either prefixed or ſubjoined to the expreſſion of vocal ſound.

CONSONANTS are thus formed; and theſe may be diſtinguiſhed in two different reſpects; *firſt*, by the poſition of the organ in which they are formed; and, *2dly*, by the operation of the breath which is employed to make them audible. It is only in thus analyſing the ſubject, that thoſe conſonants, or the articulating powers, may be underſtood.

THERE are five poſitions of the organ by which the vocal ſound is to be articulated; and theſe muſt be underſtood, before the operation of the ſounding organ in forming conſonants, can be explained. Theſe poſitions, with their reſpective modifications, therefore, are now to be deſcribed.

THE *firſt* poſition is formed by the cloſe junction of the lips, ſo as no breath is ſuffered to tranſpire; and this is the firſt modification of this poſition, when the paſſage of the breath or ſound, by the noſe, is ſtopped, and may be termed the oral modification. In this manner are formed the letters *p* and *b*.

THE

The *second* modification of this first position, which may be termed the nasal modification, is formed by opening the communication or exit by the nose, and suffering the sound or breath to pass that way. In this case the letter *m* is sounded.

The *second* position is formed by the application of the under lip to the fore teeth of the upper jaw, which does not form an absolute interruption to the breath, but suffers it to pass in an audible manner, by means of the restraint with which it is made to pass. In this manner are produced the letters *f* and *v*.

The *third* position is formed by a similar application of the tongue to the fore teeth, and a similar expression of the breath; thus producing the two consonants *θ* and *th*.

The *fourth* position is formed by the application of the point or fore part of the tongue, to the root of the same teeth, or fore part of the palate. This forms a position that may be variously modified, by means of the great volubility of this member which is thus applied.

In the *first* of these modifications, the tongue is applied closely to the palate, so as to form an absolute interruption of the breath, in a similar manner to that of the first position. It may be therefore termed the mute modification of this position. In this mute modification are formed the consonants *t* and *d*.

In the *second* modification, the tongue is not kept close fixed to the palate, but suffers the breath to be expressed in an audible manner, similar to those of the second and third positions. This, then, may be termed the sibilating modification, by which are expressed the *ſ* and *z*.

In the *third* modification, the passage of the breath between the point of the tongue and the palate is opened, and that by turns, in a quick or tremulous vibration. It may therefore be termed the vibratory modification, by which the letter *r* is formed.

In the *fourth* modification, the paſſage of the breath or ſound is not interrupted in any degree, but is made to paſs in a very peculiar manner through the mouth. For this purpoſe the tongue is cloſely applied to the fore part of the palate, but it is retracted on each ſide, ſo as to leave an open ſpace. A free paſſage is thus preſerved for the breath which goes under the tongue and out of the mouth. This may be termed the liquid modification, in which is formed the ſonorous letter *l*.

The *fifth* and *laſt* modification is formed by ſhutting thoſe lateral paſſages for the breath which were opened in the laſt modification, and at the ſame time ſuffering the ſound to paſs by the naſal paſſage, in the ſame manner as in the ſecond modification of the firſt poſition. Thus we produce the letter *n*, in what may be termed the naſal modification,

The *fifth* poſition is formed in all reſpects like the fourth, but only by a different part of the tongue and palate. There are therefore the ſame number of modifications in this poſition as in the former; and theſe, correſponding in their nature, may be denominated in the ſame manner.

We have thus the letters *k* and *g* formed in the mute modification; the *ſh* and *j* in the ſibilating modification; the guttural or Northumbrian *r* in the vibratory modification; the Spaniſh *ll*, or the French *l mouillée*, in the liquid modification; and the guttural *n*, or Engliſh *ng*, in the naſal modification.

The ſeveral poſitions of the organ, with their different modifications, being thus underſtood, the formation of the conſonants, and articulations of voice, by the action of the breath and ſound, may be now explained.

In all the poſitions of the articulating organ, there is either employed the ſimple aſpiration of the breath, or a ſound produced in the windpipe, and modified in the articulating organ. Thus, in all the poſitions, and in ſeveral of their modifications, there are produced two diſtinct articulators, according either as ſound is emitted along with the articulation, or only the breath employed

employed without any other ſound. Hence the diſtinction of mutes and conſonants among the articulators of voice.

BUT in each of theſe diſtinctions of mutes and conſonants, there is to be made a ſub-diſtinction, according as the articulator is either perfect or imperfect, whether as a mute or as a conſonant. Each of theſe will now require ſome explanation.

THE perfect mute can only take place in thoſe poſitions, in which the breath is abſolutely interrupted by the cloſe or impervious organ; and this does not happen in the ſecond and third poſitions, and only in ſome of the modifications of the fourth and fifth.

THIS mute articulator is formed, either by interrupting the vocal ſound with the cloſe poſition, in which caſe it is a final articulator; or by beginning to expreſs the vocal ſound in this cloſe poſition, when it forms, upon opening the paſſage, an initial articulator.

THERE are juſt three articulators of this kind, correſponding to the three poſitions in which the organ may be abſolutely cloſed, in relation to the exit of the breath. Theſe are *p* in the firſt poſition, *t* in the fourth poſition, and *k* in the fifth poſition.

THE imperfect mute is formed by emitting a guttural ſound, or that of the windpipe, in thoſe three poſitions of the mute articulator. The ſound here is extremely limited; for it is neceſſarily reſtricted to that quantity of breath which may be expelled through the ſounding windpipe, in compreſſing the air, or diſtending the cavity of the cloſe organ. Theſe ſhort ſounded articulators may therefore be termed imperfect mutes.

THE *b*, *d* and *g*, are the three imperfect mutes, correſponding to the three abſolute mutes, *p*, *t*, *k*, of the firſt, fourth and fifth poſitions.

IN the ſibilating articulators of the ſecond and third poſitions, and of the ſecond modification of the fourth and fifth poſitions, the breath may be continually emitted, either with the ſimple

expiration, or attended with the guttural ſound. This then forms two caſes of articulation, differing from each other, and alſo from the other two caſes of mute articulation; ſeeing that in the preſent caſe, whether the conſonant be formed with a guttural ſound, or only an audible aſpiration, it is a continued thing, and is not neceſſarily terminated, as in the mutes, by the cloſe poſition of the organ. Now, as in the caſe of mutes, we have the diſtinction of perfect and imperfect, with regard to that ſpecies of letter, ſo, in the caſe of conſonants, we have a ſpecies which is perfect, and one which is imperfect.

The imperfect ſpecies of conſonant-articulators, is formed in the four ſibilating poſitions and modifications juſt now mentioned, *viz.* the *f* in the ſecond poſition, the *θ* in the third poſition, the *ſ* in the ſibilating modification of the fourth, and the *ſh* in that of the fifth poſition.

To perfect thoſe four conſonants, we have but to add the guttural ſound to the continued expiration; and we then produce of the *f* the *v*, of the *θ* the *th*, of the *ſ* the *z*, and of the *ſh* the *j*.

We have now only remaining the naſal modification of the firſt poſition, which gives the conſonant *m*; the vibratory modification of the fourth and fifth poſitions, which give two ſpecies of the letter *r*; the liquid modifications, which give two ſpecies of the letter *l*; and the naſal modifications of thoſe two laſt poſitions, which give two ſpecies of the letter *n*. In none of all theſe, is there formed a diſtinct articulator, by means of the ſimple aſpiration; conſequently all theſe are perfect conſonants.

The alphabet is thus completed, in comprehending every poſſible vowel and articulator which are proper for diſtinct ſpeech, except the audible aſpiration of the letter *h*; and this is a general articulator, which is formed in many different poſitions of the vocal organ.

As

As the perfect vowels may be either prolonged with the expirated breath, or cut ſhort by a change in the modifying organ, we have the means of adding quantity to the ſpecifying ſounds of ſpeech, whereby another diſtinction is formed of our vocal ſounds.

We have alſo the power of compounding vocal ſounds for the increaſe of the radical alphabet of vowels, which is ſo limited.

Diphthongs and conſonant-vowels, or rather articulating vowels, are formed in the following manner: The diphthong, by ſounding both vowels equally in the time of one; the conſonant-vowel again, by an unequal diviſion of this time, or by ſliding quickly from the poſition of the two extreme vowels *i* and *u*, to the vocal ſound which is to be thus articulated.

Having thus ſhown that there is in nature a perfect alphabet as the principles of ſpeech, at leaſt that there is an alphabet which is perfectly definable in ſcience, it is propoſed to adhere ſtrictly to this alphabet as the principles of writing, with a view to perfect ſpeech, in having diſtinct ſounds; and to perfect writing, in having ſteady principles for the commutation of ſound and figure.

To give ſome idea of this; there are juſt two practicable ways of writing ſpeech with any manner of advantage. Theſe are either by figuring ſimple ſounds, which is the alphabetical method, or by figuring compound ſounds, which is the verbal method.

The Engliſh method, which ſhould be alphabetical, is not truly ſo, ſeeing it has departed egregiouſly from its principles, in ſo far adopting the other method; this is that of typifying words by means of ſigns, which are not expreſſive of the ſound, but of the ſenſe; whereas it ſhould employ only thoſe ſigns which have affixed to them an unalterable expreſſion, not of the ſenſe, but of the ſound. We write a word by a combination of letters, not properly expreſſive of the ſpeech which we pronounce,

pronounce, but conventionally ſpecifying the word which we then render into ſpeech.

THE advantages ariſing from a ſtrict adherence to the ſcientific method of the alphabet, are of two kinds; one relating immediately to the people who would thus acquire great facility in learning to read and write; the other relating immediately to the language, which would thus become uniform and ſteady, and would avoid corruption.

IF a perſon has learned to write every vocal ſound, and every articulation which his organs form for the uſe of ſpeech, all which are compriſed within the compaſs of the alphabet, he has it in his power to write any ſpeech which he is able to pronounce. He would alſo write that ſpeech preciſely in the manner that every other perſon, who has learned the alphabet, muſt render it again in reading.

NOW, if a language ſhould be thus perfectly repreſented in the writing, the perfection of our ſpeech might be, in this manner, communicated among the learned of the nation, and the improvements of our ſpeech would be diſperſed with our writings, by means of the improvement of our ſcience.

BUT if, in writing our language, any other method is purſued, which is different from the ſcientific analyſis of our ſpeech, and elemental characteriſing of our vocal ſounds, there will then be no fixed relation between our writing and the pronunciation of our language; and, in that caſe, no literary perfection in our education, will have any tendency to improve the language of the nation.

WITH regard to a reformation of our preſent method, if, on the one hand, the orthographical practice of this nation has only deviated from the truth of ſcience in a ſmall degree, it may be eaſily corrected by the exertion of literary men, when they conſider the danger of ſuch a growing evil.

NOW, that there is truly danger in the caſe, muſt appear by conſidering how little apprehenſion there is in general of this

error

error in our practice, notwithstanding the length to which it is arrived.

If, on the other hand, our writing has departed much from the rules of just orthography, in that case, however well disposed for a reformation, it is not in the power of a few individuals, to make so great a change in the literary system of the country, as this reformation would require.

But if there is to be acknowledged any advantage in the alphabetical method, the very difficulty of undertaking such a reformation, affords the strongest argument for the expediency of the measure.

This will appear by considering, that in departing from the alphabetical rule, we lose the literary advantage of the elemental method; at the same time, we do not derive from the verbal method, then so far pursued, that benefit which the Chinese have, in compensation for their want of alphabetical orthography.

The corruption of the Chinese orthography may naturally lead to the introduction of the alphabetical method. But the corruption of the alphabetical method, while it introduces a real difficulty and confusion into our orthography, is attended with no advantage, except perhaps the ideal pleasure of some speculative men, when in pursuit of the derivation of the language.

1786. July 3. Thomassen on petrification.

Phys. Cl. Dr Walker, Professor of Natural History, read a paper on Petrifaction, by Everardus Joannes Thomassen à Theussinck, of Zwoll in Holland.

July 17. Dr Hutton on written language.

Lit. Cl. Dr Hutton read a continuation of his Dissertation on Written Language as a Sign of Speech. [See *supra*, June 19.]

Phys.

1787. ſent to the Society by the author, the latter by M. L'ABBE TRESSAN, the author's ſon. The Secretary alſo preſented from Dr BLANE his Obſervations on the Diſeaſes of Seamen. Theſe books are in the liſt of donations printed in Vol. I. of the Society's Tranſactions.

Feb. 5. Mr Robiſon on the Georgium Sidus.

Phyſ. Cl. Mr Profeſſor ROBISON read a Compariſon of the Theory of the Motion of the New Planet, read by him laſt year, with ſome additional obſervations made by him ſince. [See Vol. I. No. XI. *Phyſ. Cl.*]

Volcanic eruptions in Iceland.

AT the ſame Meeting, Dr WALKER read an Extract from an Account of the Volcanic Eruptions in Iceland during the year 1783.

Feb. 19. Mr Young on muſic and poetry.

Lit. Cl. Mr ROBISON read the remaining part of the Reverend Mr WALTER YOUNG's Diſſertation on Muſic and Poetry; which is printed in this volume. [No. III. *Lit. Cl.*]

March 5. Experiments by Dr Home.

Phyſ. Cl. Dr FRANCIS HOME read an Account of ſome Medical Experiments made by him upon the *Digitalis*.

March 19. Dr Beattie on the ſixth book of the Eneid.

Lit. Cl. Mr DALZEL read a Diſſertation by Dr JAMES BEATTIE, Profeſſor of Philoſophy in the Mariſchal College of Aberdeen, entitled, Remarks on ſome Paſſages of the ſixth Book of the Eneid. This Diſſertation is printed in this volume. [No. II. *Lit. Cl.*]

April 2. Mr Wallace on the eaſt wind.

Phyſ. Cl. GEORGE WALLACE, Eſq; Advocate, read a part of a Diſſertation on the Cauſes of the Diſagreeableneſs and Coldneſs of the Eaſt Wind. The author did not incline that any abſtract ſhould be given of this Diſſertation.

Lit.

1787. April 16. Letter from the Teſhoo Lama to Mr Haſtings.

Lit. Cl. Mr MACONOCHIE communicated from ROBERT BOGLE of Daldowie, Eſq; a copy of a letter, written in 1773, by the Teſhoo Lama of Thibet, to WARREN HASTINGS, Eſq; Governor-general of Bengal, while a brother of Mr BOGLE's was reſiding at the Lama's court, as envoy from Mr HASTINGS. Mr MACONOCHIE remarked, that the turn of thought and expreſſion rendered the letter a very great curioſity; but that it was ſtill more intereſting on two accounts: *firſt*, That it eſtabliſhed beyond all queſtion, that the Teſhoo Lama, though a Pontiff of inferior rank to the Dalai Lama, is underſtood to poſſeſs the ſoul of ſaints, or divine perſonages that flouriſhed in former times, and to retain the remembrance of what happened to them in thoſe paſt periods of exiſtence. *2dly*, That the ſame places which are regarded in Bengal as peculiarly ſacred, are likewiſe regarded by the religion of Fo as holy; that the Teſhoo Lama, in ſome of his former ſtates of exiſtence, is ſuppoſed to have reſided in thoſe places; that the Ganges, ſo revered among the Brahmins, is alſo revered by the worſhippers of Fo; and that the reference by the followers of that religion in Japan, to ſome region in India, as the origin and holy land of their faith, is here aſcertained to belong to Bengal. Theſe circumſtances, he thought, ſuggeſted very important reflections with regard to the hiſtory of the religions of Eaſtern Aſia.

THE letter is as follows:

From TESHOO LAMA to the GOVERNOR.

Received the 22d July 1775.

" Mr BOGLE, whom, out of your kindneſs, you were pleaſed " to ſend into this quarter, having (thank GOD) arrived here in " perfect health, I had, at an auſpicious hour, the pleaſure of an " interview with him, and was rendered ſo completely happy on " the occaſion, that it might in reality have been thought an in-

1787. ſent to the Society by the author, the latter by M. L'ABBE TRESSAN, the author's ſon. The Secretary alſo preſented from Dr BLANE his Obſervations on the Diſeaſes of Seamen. Theſe books are in the liſt of donations printed in Vol. I. of the Society's Tranſactions.

Feb. 5. Mr Robiſon on the Georgium Sidus.

Phyſ. Cl. Mr Profeſſor ROBISON read a Compariſon of the Theory of the Motion of the New Planet, read by him laſt year, with ſome additional obſervations made by him ſince. [See Vol. I. No. XI. *Phyſ. Cl.*]

Volcanic eruptions in Iceland.

AT the ſame Meeting, Dr WALKER read an Extract from an Account of the Volcanic Eruptions in Iceland during the year 1783.

Feb. 19. Mr Young on muſic and poetry.

Lit. Cl. Mr ROBISON read the remaining part of the Reverend Mr WALTER YOUNG's Diſſertation on Muſic and Poetry; which is printed in this volume. [No. III. *Lit. Cl.*]

March 5. Experiments by Dr Home.

Phyſ. Cl. Dr FRANCIS HOME read an Account of ſome Medical Experiments made by him upon the *Digitalis*.

March 19. Dr Beattie on the ſixth book of the Eneid.

Lit. Cl. Mr DALZEL read a Diſſertation by Dr JAMES BEATTIE, Profeſſor of Philoſophy in the Mariſchal College of Aberdeen, entitled, Remarks on ſome Paſſages of the ſixth Book of the Eneid. This Diſſertation is printed in this volume. [No. II. *Lit. Cl.*]

April 2. Mr Wallace on the eaſt wind.

Phyſ. Cl. GEORGE WALLACE, Eſq; Advocate, read a part of a Diſſertation on the Cauſes of the Diſagreeableneſs and Coldneſs of the Eaſt Wind. The author did not incline that any abſtract ſhould be given of this Diſſertation.

Lit.

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" terview with yourſelf. The letter which you addreſſed to me, " and the preſents you ſent by Mr BOGLE, I have likewiſe re- " ceived ſafe. May your happineſs and proſperity daily in- " creaſe. All the particulars which Mr BOGLE verbally repre- " ſented to me, I perfectly underſtand. You were pleaſed to " write me, that you had ſent orders for eſtabliſhing peace with " the Debe Doria, agreeable to my requeſt. True; the pleaſure " theſe particulars gave me, it is impoſſible to expreſs. When " you, out of pure friendſhip, are induced thus readily to com- " ply with a requeſt of mine, what return can I make you for " it, but offer you my prayers? You have laid me under an ob- " ligation to you for ever; and I hope that you will every where " prove victorious and ſucceſsful. What can I ſay to you of my " own ſituation? In former ages, I repeatedly received my ex- " iſtence from Allahabad, Benares, Patna, Purnea, and other " places in Bengal and Oriſſa; and having ever enjoyed much " happineſs from thoſe places, I have imbibed a partiality for " them; and a ſincere love and affection for their inhabitants " are ſtrongly impreſſed on my heart. The well known place of " Outragund gave me my laſt exiſtence; and thanks be to GOD, " the inhabitants of this quarter are all content and ſatisfied with " me. Where my ſpiritual eſſence will tranſmigrate to next, will " hereafter be ſeen. At preſent, here I ſit in this icy country, " in obedience and ſubjection to the Emperor of China. I have " long had a deſire of ſeeing you, and the dominions and people " over whom you rule; but hitherto many cauſes have occurred " to prevent me, whatever may happen in future. My travelling ſo " far as your country, to obtain a perſonal interview with you, " muſt, however, be attended with many unſurmountable diffi- " culties, and Providence has decreed that we ſhould be at this " neceſſary diſtance from each other. From this conſideration, " I am induced to requeſt that you will grant me a piece of " ground near the ſea-ſide, that I may build a houſe of wor- " ſhip thereupon; and for the expences of building it, I have

" ſent

" ſent an hundred pieces of gold by Mr BOGLE, together with " ſome carpets, cloths, and other neceſſaries, which he will ſhew " you, for the decoration of it; and I requeſt that you will do " me the favour to let the houſe be immediately built, and the " things put up; and as ſoon as the cold ſeaſon ſets in, I will " certainly diſpatch to you ſome of my own people, if not ſome " of the family of the Lama, who is patron of the Emperor of " China. I hope that you will receive them with kindneſs, and " ſend ſome of your own ſervants with them, to viſit every place " of worſhip at Allahabad, Benares, *&c.* for the diſcharge of their " religious duties. As this country is under the abſolute ſove- " reignty of the Emperor of China, who maintains an active and " unrelaxed control over all its affairs; and as the forming of any " connection or friendſhip with foreign powers is contrary to his " pleaſure, it will frequently be out of my power to diſpatch any " meſſengers to you. However, it will be impoſſible to efface the " remembrance of you out of my mind; and I ſhall always pray " for the increaſe of your happineſs and proſperity, and, in re- " turn, I hope you will frequently favour me with accounts of " your health. To avoid troubling you, and intruding longer " upon your time with my incorrect ſtyle, I ſhall conclude this, " but beg you will favour me with an anſwer; and I ſhall take " an opportunity of addreſſing you by every perſon who goes " from hence into your part of the world. I have repreſented all " particulars to Mr BOGLE, who will communicate them to you, " and I hope you will conſent to them.

[*On a ſeparate paper.*]

" HAVING, in compliance with my requeſt, put an end to " hoſtilities with the Debe Raja, and eſtabliſhed a peace with " him, you have thereby conferred upon me the greateſt obliga- " tion. As a teſtimony whereof, I ſend you a preſent of a few " things; and, although not worth acceptance, I beg you will ac-

" cept

1787. " cept of them, merely upon this consideration, that a green leaf
" is a present from a hermit.

" *List of Presents.*

" 8 pieces of China satin.
" 1 silver talent of China.
" 1 Pelong handkerchief.

" I CAN make no suitable return for your friendship from this " part of the world, and I hope you will excuse it. POORUN " KER CUSHOO will have the honour of paying his respects to " you; and I hope you will grant him your favour and protec- " tion in the business with which he is entrusted."

June 18. Dr Gregory on the moods of verbs.

Lit. Cl. Dr GREGORY read a Philological Dissertation, entitled, Theory of the Moods of Verbs; which is published in this volume. [No. IV. *Lit. Cl.*]

July 2. Mr Wallace on the east wind.

Phys. Cl. Mr GEORGE WALLACE read the continuation of his Dissertation on the Causes of the Disagreeableness and Coldness of the East Wind. [See *supra*, April 2.]

Letter from the President de Virly.

AT the same Meeting, the following Letter from the President de Virly, at Dijon, was read:

A Paris ce 10me Mars 1787.

On the use of caustic alkali in the cure of gravelish disorders.

" IL sera peut être agréable à la Societé d'apprendre que l'on " a appliqué à Dijon, avec succès un remede que l'on doit à " un medecin de votre isle: l'alkali caustique pris intérieure- " ment pour le calcul ou la pierre. M. DURANDE, medecin " de cette ville a eu un malade qui avoit rendu beaucoup de " gravier par les urines, et avoit de grandes douleurs. Le ma- " lade, en même tems, ne vouloit pas entendre parler de se

" faire

"faire sonder. M. Durande lui a administré l'alkali caustique dans un bouillon de veau, qui contenoit à peu près une livre d'eau. Il a commencé par dix gouttes, et a fini, en augmentant la dose, par l'administrer jusqu'à quarante gouttes. Au bout de six semaines, les accidens avoient tellement cessé que le malade a dit n'avoir plus besoin de rien. Il y a dix mois, et il se trouve très bien. 1787.

"Un autre malade a commencé le même remede. Un verre de son urine le cinquieme jour de traitement, tems auquel il prenoit douze gouttes d'alkali caustique, a été essayé. Le papier de Fernambouc s'est très legerement altéré. L'eau chargée d'air fixe a troublé un verre de cette urine, et y a occasioné un très leger dépot. On sait que l'eau gaseuse reprend l'alkali à la matiere du calcul.

"On s'etoit assuré par le papier teint avec le jus de mauve que le bouillon ne dénaturoit point l'alkali caustique. Il faut avoir soin que l'alkali soit bien caustique, et n'aye pas perdu sa vertu par le contact de l'air.

"Il s'est presenté à moi un fait en Angleterre, qui, je crois, n'a pas été encore observé. C'est une éspece de basalte artificiel. En examinant, auprès de Sheffield, des matériaux pour réparer la route, je cassai plusieurs de ces morceaux de terre cuite dont on se sert dans plusieurs endroits de l'Angleterre pour réparer les chemins. Ces morceaux se cassoient en prismes hexagones très réguliers, tels que ceux des basaltes. Les differentes personnes à qui je les ai montrés, notamment M. Watt, ne les connoissoient pas. Je n'en avois jamais vu non plus. Je vous serai obligé Monsieur, de communiquer ce fait à Mons. le Dr Hutton, qui a fait beaucoup d'observations, dont on verra surement la publicité avec grand plaisir. J'ai l'honneur d'étre," &c.

Of an artificial basaltes.

Lit. Cl. Dr Gregory read the continuation of his Theory of the Moods of Verbs, published in this volume. [No. IV. *Lit. Cl.*]

July 16. Dr Gregory on the moods of verbs.

Phys.

1787.
August 6.
New species of cochineal.

Phyſ. Cl. Dr JAMES ANDERSON laid before the Society a ſpecimen of a new ſpecies of cochineal, lately diſcovered on the coaſt of Coromandel by JAMES ANDERSON, M. D. Phyſician-general at Madraſs.

Count de Windiſchgratz's problem.

AT the ſame Meeting, Mr Commiſſioner SMITH acquainted the Society, that the Count de WINDISCHGRATZ had tranſmitted to him three Diſſertations, offered as ſolutions of his Problem, [See Tranſactions, Vol. I. Hiſt. of the Soc. p. 37. & 45.] and had deſired the judgment of the Society upon their merits. The Society referred the conſideration of theſe papers to Mr SMITH, Mr HENRY MACKENZIE of the Exchequer, and Mr WILLIAM CRAIG, Advocate, as a Committee to peruſe and conſider them, and to report their opinion to the Society at a ſubſequent Meeting.

Nov. 5.
Mr Lochead on the nat. hiſt. of Madeira.

Phyſ. Cl. Dr WALKER, Profeſſor of Natural Hiſtory, read part of a Diſſertation, written by Mr LOCHEAD, on the Natural Hiſtory of Madeira.

Nov. 19.
Mr Dalzel on the Greek Σ.

Lit. Cl. Mr DALZEL read the continuation of his Diſſertation on certain Analogies obſerved by the Greeks in the uſe of their Letters; and particularly of the Letter Σ. [See *ſupra*, Dec. 19. 1785.]

Nov. 26.
General Meeting.

A GENERAL Meeting of the Royal Society was held for the election of General Office-bearers for the enſuing year; when all thoſe of the preceding year were re-elected.

Dec. 3.
Dr Hutton's anſwers to M. de Luc.

Phyſ. Cl. Dr JAMES HUTTON read Anſwers by him to the Objections of M. DE LUC, with regard to his Theory of Rain, (publiſhed in Tranſactions, Vol. I. No. II. *Phyſ. Cl.*) Theſe Anſwers are printed in this volume. [No. VIII. *Phyſ. Cl.*]

Lit.

Lit. Cl. Mr DALZEL read an Eſſay on the Standard of Taſte, and on the Nature and Hiſtory of Criticiſm. He did not incline that this Eſſay, or any abſtract of it, ſhould be printed in this volume. 1787. Dec. 17. Mr Dalzel on the ſtandard of taſte.

HE alſo read a ſhort Eſſay by the Reverend Mr ROBERTSON, Miniſter of Dalmeny, on the Subjunctive Mode in Engliſh Verbs, and on *ſhall* and *will*. The author did not incline that any account of this Eſſay ſhould be given in this volume. Mr Robertſon on the ſubjunctive mode in Engliſh verbs.

Phyſ. Cl. Dr WALKER read a continuation of Mr LOCHEAD's paper on the Natural Hiſtory of Madeira. [See *ſupra*, Nov. 5. 1787.] 1788. Jan. 7. Mr Lochead on the nat. hiſt. of Madeira.

Lit. Cl. Mr MACONOCHIE read a paper containing Obſervations reſpecting the Country, Religion, Political Inſtitutions, and Sciences of the Hindoos. Jan. 21. Mr Maconochie on the Hindoos.

AT the ſame Meeting, Mr Commiſſioner SMITH reported the opinion of the Committee appointed to examine the three Diſſertations offered as Solutions of the Count de WINDISCHGRATZ's Problem, [See *ſupra*, Aug. 6. 1787.]; which was, That none of the three Diſſertations amounted, either to a ſolution, or to an approximation towards a ſolution of that problem. The Committee, however, intimated their opinion, that one of theſe Diſſertations, ſuperſcribed with the following ſentence, *Si quid noviſti rectius iſtis*, &c. though neither a ſolution of the problem nor an approximation to it, was a work of great merit. The Royal Society, hereupon, pronounced their judgment in terms of the ſaid report; and they requeſted Mr FRASER TYTLER to tranſmit this judgment, and the opinion of the Committee, by a letter to the Count de WINDISCHGRATZ. Report and judgment relative to the Count de Windiſchgratz's problem.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See Liſt in the Appendix to the Hiſtory of the Society.] Jan. 28. General Meeting.

1788.
Feb. 4.
Sir James Hall on Lavoiſier's theory of chemiſtry.

Phyſ. Cl. Sir JAMES HALL, Baronet, read part of a paper entitled, A View of M. LAVOISIER's new Theory of Chemiſtry. He did not incline that this paper, or any abſtract of it, ſhould be printed in this volume.

Feb. 18.
Dr Hill on ſynonymous words.

Lit. Cl. Dr JOHN HILL read part of an Eſſay on Synonymous Words. As this Eſſay forms part of a larger work, which is not yet completed, the author did not chuſe that any abſtract of it ſhould be given in this volume.

March 3.
Sir James Hall on Lavoiſier's chemiſtry.

Phyſ. Cl. Sir JAMES HALL read a ſecond part of his paper on M. LAVOISIER's new Theory of Chemiſtry. [See *ſupra*, Feb. 4.]

Spirits diſtilled from carrots.

AT the ſame Meeting, the Secretary read a communication from Dr HUNTER and Mr HORNBY of York, reſpecting the Diſtillation of Ardent Spirits from Carrots. A ſpecimen of the Spirits had likewiſe been ſent to the Royal Society. The Society appointed Dr BLACK, Dr HUTTON, and Mr JAMES RUSSELL, ſurgeon, to examine this account, together with the ſpecimen of the ſpirits, and to report upon the ſame.

March 17.
Biographical account of the Lord Preſident Dundas.

Lit. Cl. Mr FRASER TYTLER read a Biographical Account of the late Lord Preſident DUNDAS; which is publiſhed in this volume. [Appendix to the Hiſtory of the Society.]

Mr Ramſay on the funeral rites of the Highlanders.

Mr Profeſſor FINLAYSON read a Diſſertation by JOHN RAMSAY, Eſq; of Auchtertyre, on the Funeral Rites of the Highlanders.

April 7.
Mr Robiſon on the motion of light.

Phyſ. Cl. Mr PLAYFAIR read a paper by Mr JOHN ROBISON, Profeſſor of Natural Philoſophy, on the Motion of Light, as affected by Refracting and Reflecting Subſtances, which are alſo in motion. This paper is publiſhed in this volume. [No. XI. *Phyſ. Cl.*]

AT

1788. April 7. Sir James Hall on Lavoisier's chemistry.

AT the same Meeting, Sir JAMES HALL read the concluding part of his View of M. LAVOISIER's Theory of Chemistry. [See *supra*, Feb. 4. and March 3. 1788.]

April 21. Mr Mackenzie on the German theatre.

Lit. Cl. Mr HENRY MACKENZIE read an Account of the German Theatre, with Remarks upon Dramatic Performances in general. This paper is printed in this volume. [No. V. *Lit. Cl.*

May 5. Dr Hutton on phlogiston.

Phys. Cl. Dr HUTTON read a paper on Phlogiston, in answer to the Observations of Sir JAMES HALL, in his Account of M. LAVOISIER's Chemistry.

May 12. Dr Hutton and Sir James Hall on phlogiston.

Phys. Cl. THE Society met this day *extra ordinem*. Dr HUTTON read some further Observations on Phlogiston; and Sir JAMES HALL read a paper in reply to Dr HUTTON's former Observations on that subject.

June 23. General Meeting.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See List in the Appendix to the History of the Society.]

July 7. Dr Anderson on a new species of cochineal.

Phys. Cl. An Account was read by Dr JAMES ANDERSON, of thirteen letters from JAMES ANDERSON, M. D. Physician at Madrass, to Sir JOSEPH BANKS, F. R. S. Lond. respecting the Discovery of a new species of Cochineal. [See *supra*, Aug. 6. 1787.]

July 21. Mr Robertson on the character of Hamlet.

Lit. Cl. Mr DALZEL read a Dissertation by Mr THOMAS ROBERTSON, Minister of Dalmeny, on the Character of SHAKESPEARE's HAMLET. This paper is printed in this volume. [No. VII. *Lit. Cl.*]

1788. Nov. 3. Mr Small on ventilation.

Phyſ. Cl. Mr DALZEL read an Eſſay on Ventilation, by ALEXANDER SMALL, Eſquire.

Spirits diſtilled from carrots.

AT the ſame Meeting, a Report was preſented from Dr BLACK, Dr HUTTON, and Mr RUSSELL, on Dr HUNTER and Mr HORNBY's proceſs for producing an ardent ſpirit from carrots. [See *ſupra*, March 3. 1788.] The report is as follows:

WE have examined the ſample of ſpirits, which was ſent by Dr HUNTER of York to the Royal Society, and we have read the account of the experiment on the fermentation and diſtillation of carrots by which the ſaid ſpirit was produced. The experiment was made by Mr THOMAS HORNBY, druggiſt in York, with one ton and eight ſtone of carrots, which, after being expoſed to the air a few days to dry, weighed 160 ſtone, and meaſured 42 buſhels; they were waſhed, topped and tailed, by which they loſt in weight 11 ſtone, and in meaſure ſeven buſhels; being then cut, they were boiled with the proportion of 24 gallons of water to one third of the above quantity of carrots, until the whole was reduced to a tender pulp, which was done in three hours boiling. From this pulp, the juice was eaſily extracted by means of a preſs, and 200 gallons of juice were produced from the whole. This juice was boiled again with one pound of hops five hours, and then cooled to 66 of FAHRENHEIT, and ſix quarts of yeaſt being added, it was ſet to ferment. The ſtrong fermentation laſted 48 hours, during which time the heat abated to 58 of FAHRENHEIT; 12 gallons of unfermented juice, which had been reſerved, were then heated and added to the liquor, the heat of which was thus raiſed again to 66, and the fermentation was renewed for 24 hours more, the air of the brewhouſe being all this time at 46 and 44. The liquor was now turned, and continued to work three days from the bung; and, laſtly, it was diſtilled, and the firſt diſtillation was rectified next day without any addition.

dition. The produce was twelve gallons, of the ſame quality with the ſample. 1788.

In our examination of this ſample, we found it reſembled a corn ſpirit in flavour, but was equal to a corn ſpirit of the beſt kind, and it was a proof ſpirit.

The refuſe of the carrots weighed 48 ſtone, which, added to the tops and tails, made proviſion for hogs, beſide the waſh from the ſtill, which meaſured 114 gallons.

From this experiment, Dr Hunter draws the following compariſon between the diſtillation of carrots and that of grain:

20 tons of carrots, which will make 200 gallons of proof ſpirits, may be bought for L. 16.

8 quarters of malt, or rather the materials for diſtillation, conſiſting of malt, wheat and rye, may be bought for L. 16, and will alſo make 200 gallons of proof ſpirit.

The refuſe from the carrots will be 960 ſtone, which, at 1 d. *per* ſtone, will ſell for L. 4.

The refuſe or grains from the malt, *&c.* will be 64 buſhels, each buſhel weighing about 3 ſtone, which, at 1 d. *per* ſtone, will ſell for 16 s.

The Doctor, however, ſuppoſes, that the manufacturing of the ſpirit from carrots may be attended with more expence than the manufacturing of it from malt; but imagines that the greater value of the refuſe may compenſate for that expence, and that the ſaving of corn for other purpoſes, is an object worthy of attention and of encouragement.

(Signed) Joseph Black.
19th May 1788. James Russell.
James Hutton.

Phyſ. Cl. Dr William Wright, F. R. S. Lond. read a Botanical and Medical Account of the Quaſſia Simaruba; which is printed in this volume. [No. X. *Phyſ. Cl.*] Dec. 1. Dr Wright on quaſſia ſimaruba.

At

1788. Dec. 1. Sir Ja. Hall on pumice stone.

At the same Meeting, Sir JAMES HALL read a paper on the Formation of Pumice Stone.

Mr Leslie on the solution of certain math. problems.

Mr PLAYFAIR read a paper by Mr JOHN LESLIE, on the Solution of certain indeterminate Problems in Mathematics. This paper is printed in this volume. [No. XIV. *Phys. Cl.*]

Dec. 15. Dr Hill on syn. words.

Lit. Cl. Dr JOHN HILL read a continuation of his Essay on Synonymous Words. [See *supra*, Feb. 18. 1788.]

APPEN-

A P P E N D I X.

January 1. 1790.

LIST of MEMBERS *or* FELLOWS *of the* ROYAL SOCIETY *of Edinburgh, continued from January* 1. 1788. *when the first Volume was published.*

OMITTED by mistake in the former LIST.

* *Robert Hamilton*, M. D. Fellow of the Royal College of Physicians, and Physician at Lynn Regis, in Norfolk. *P.*

THE following were elected at the General Meeting, Jan. 28. 1788. Members chosen, Jan. 28. 1788.

1. RESIDENT.

Mr *Robert Ker*, Surgeon in Edinburgh. *P.*

2. NON-RESIDENT.

William Hamilton, M. A. Fellow of Trinity College, Dublin. *L.*
Robert Adam, Esq; Architect to King GEORGE III. and Queen CHARLOTTE, F. R. S. & S. A. Lond. &c. *L.*
Caleb Whiteford, Esq; Lond. *L.*
Major-general *William Roy*, F. R. S. Lond. *P.*
George Dempster, Esq; of Dunnichen. *L.*
Charles Thomas Hope, M. D. Professor of Medicine in the University of Glasgow. *P.*

Mr

Mr *John Rennie*, Engineer, London. *P.*
Lieutenant *Robert Arbuthnot*. *L.*

3. FOREIGN.

M. L'Abbé *Raynal*.

Members chosen, June 23. 1788.

THE following were elected at the General Meeting, June 23. 1788.

1. RESIDENT.

Thomas Spens, M. D. Edinburgh. *P.*
Lewis Alexander Grant, Esq; of Grant, Advocate. *L.*
David Smyth, Esq; of Methven. *L.*
Charles Hope, Esq; Advocate. *L.*
John Wilde, Esq; Advocate. *L.*
The Reverend Mr *William Moodie*, Minister of St Andrew's Church, Edinburgh. *L.*

2. NON-RESIDENT.

Robert Cleghorn, M. D. Glasgow. *P.*
Robert Bogle, Esq; of Daldowie. *L.*
William Lister, M. D. Lond.

Members chosen, Jan. 26. 1789.

THE following were elected at the General Meeting, Jan. 26. 1789.

1. NON-RESIDENT.

Bartholomew Parr, M. D. of Exeter. *P.*
John Drummond, M. D. of Jamaica. *P.*
John Ogilvy, D. D. Minister at Midmar. *L.*
General *Robert Melvil*. *L.*

2. FO-

2. Foreign.

M. *Guyot*, of Paris.

Mr *Jefferſon*, Miniſter Plenipotentiary from the States of America, at Paris.

The following were elected at the General Meeting, June 29. 1789. Members choſen, June 29. 1789.

1. Non-resident.

John Thomas Stanley, Eſq; of Alderley in Cheſhire, F. A. S. Lond.

2. Foreign.

Henry Engelhart, M. D. Profeſſor of the Practice of Phyſic in the Univerſity of Lunden.

Joachim Ramm, M. D. of Riga.

OFFICE-BEARERS of the SOCIETY.

General office-bearers.

OFFICE-BEARERS elected for the ensuing year, at the General Meeting held for that purpose, Nov. 30. 1789.

President.

His Grace the Duke of BUCCLEUGH.

Vice-Presidents.

Right Hon. *Henry Dundas.*	Lord *Dunsinnan.*

Secretary.	Treasurer.
Mr *John Robison.*	Mr *Alex. Keith.*

Counsellors.

Dr *James Hutton.*	Lord *Elliock.*
Mr *Geo. Fergusson.*	Major-Gen. *Fletcher-Campbell.*
Mr *Benjamin Bell.*	Mr Commissioner *Edgar.*
Mr *Dugald Stewart.*	Sir *William Miller*, Bart.
Dr *Daniel Rutherford.*	Dr *Adam Ferguson.*
Dr *James Gregory.*	Lord *Dregborn.*

OFFICE-

Office-bearers of the classes.

OFFICE-BEARERS of the two CLASSES.

PHYSICAL CLASS.

Presidents.

Dr *William Cullen.*	Dr *Alexander Monro.*
Dr *Francis Home.*	Dr *Joseph Black.*

Secretaries.

Dr *John Walker.*	Mr *John Playfair* *.

LITERARY CLASS.

Presidents.

Mr Baron *Gordon.*	Dr *William Robertson.*
Mr Commissioner *Smith.*	Dr *Hugh Blair.*

Secretaries.

Mr *Alex. Fraser Tytler.*	Mr *Andrew Dalzel.*

* Who had also been elected at the General Meeting, June 29. 1789, on the resignation of Dr *Gregory.*

LIST of MEMBERS deceaſed, continued from the firſt volume.

Hary Spens, D. D. Profeſſor of Divinity in the Univerſity of St Andrew's. November 27. 1787.

The Right Hon. *Robert Dundas* of Arniſton, Lord Preſident of the Court of Seſſion. December 13. 1787.

John Dryſdale, D. D. one of the Miniſters of Edinburgh, Dean of the Chapel Royal, and Principal Clerk to the Church of Scotland. June 16. 1788.

John Macfarlan, D. D. Miniſter of Canongate, and Almoner to his Majeſty. December 24. 1788.

The Reverend Mr *John Logan*, formerly one of the Miniſters of Leith. December 28. 1788.

The Right Hon. Sir *Thomas Miller*, of Glenlee, Baronet, Lord Preſident of the Court of Seſſion. September 27. 1789.

FOREIGN MEMBERS deceaſed.

M. le Comte de *Buffon*. April 16. 1788.

Petrus Camper, M. D. Holland. 1789.

SINCE the publication of the preceding volume, the following BIOGRAPHICAL ACCOUNTS have been read at different Meetings of the Claſſes.

I. Ac-

I. ACCOUNT *of the Right Honourable* ROBERT DUNDAS *of Arniſton, Lord Preſident of the Court of Seſſion in Scotland,* F. R. S. EDIN. &c.

[*Read by* ALEX. FRASER TYTLER, *Eſq; Advocate, March* 17. 1788.]

ROBERT DUNDAS of Arniſton, late Lord Preſident of the Court of Seſſion, was the deſcendant of a family to which the hiſtorian and genealogiſt have aſſigned an origin of high antiquity and ſplendor *, but which has been ſtill more remarkable for producing a ſeries of men, eminently diſtinguiſhed for their public ſervices in the higheſt civil offices of this country. If the pride of anceſtry is ever allowable, it is where thoſe anceſtors have adorned the ſtations which they filled, by that genuine merit which, independently of rank, muſt have entitled them to the reſpect and eſteem of their fellow-citizens. Such were the progenitors of the late Lord Preſident, whoſe family has produced a ſucceſſion of men, who, for four generations, have diſcharged the higheſt offices of the law in this country with equal abilities and integrity.

As the merits of ſome of theſe eminent perſons entitle them to more than general eulogy, and as there are ſome circumſtances of their lives and characters too honourable, and indeed too exemplary to be paſſed over in ſilence, I ſhall here mention a

* Sir JAMES DUNDAS, firſt Baron of Arniſton, Governor of Berwick, and knighted by King JAMES VI. was the third ſon of GEORGE DUNDAS of Dundas, (by CATHERINE, daughter of LAURENCE Lord Oliphant) the ſixteenth in deſcent from the DUNBARS Earls of March, who, according to Sir JA. DALRYMPLE, CRAWFURD, NISBET, &c. derive their origin from the Saxon Kings of England.

Account of Lord Prefident Dundas.

a few anecdotes refpecting them, as introductory to the account of *His* life, on whom I mean more particularly to enlarge.

Sir JAMES DUNDAS of Arnifton, eldeft fon of Sir JAMES DUNDAS, Governor of Berwick, by MARY, the daughter of GEORGE HOME of Wedderburn, had the honour of knighthood conferred on him by CHARLES I. In the earlier part of his life, and in the courfe of a very liberal education, he had fpent a confiderable time abroad, and vifited the politeft of the foreign Courts. On his return to his native country, he was chofen Reprefentative of the county of Edinburgh in the Scottifh Parliament; and, in the moft difficult of times, when public virtue was put to the fevereft trials, uniformly maintained the character of a fteady and fincere patriot. He difapproved, as did many of the beft friends of their King and Country, of thofe violent meafures by which CHARLES, mifguided by LAUD, endeavoured to force this kingdom to fubmit to the Epifcopal hierarchy. The ecclefiaftical and the civil liberties of the kingdom were juftly regarded as moft intimately connected with each other. The Church of Scotland, in all periods of its hiftory, whatever had been its form of government and difcipline, had uniformly rejected the idea of dependence on the Metropolitan fees of England*; and at this time, even thofe among the Scots who approved of the Epifcopal forms, could not brook that rules of difcipline fhould be prefcribed to them by Englifh ecclefiaftics. They were juftly indignant at thofe meafures which they confidered as a tyrannical endeavour to bring the National Church, hitherto independent, under a difhonourable fubjection to that of England; and they regarded the attempt to introduce an Englifh liturgy, as preparatory to the introduction of Englifh laws. This was the idea which prevailed with many virtuous men to fign the *National Covenant*, which,

* THE conteft for the independency of the National Church of Scotland had begun as early as the reign of ALEXANDER I.

which, by presenting a deliberate and a powerful opposition to that attack against their religious and civil liberties, bad fair to prevail with the Sovereign to abandon those unconstitutional attempts, and thus might have been the means of preserving the peace of the kingdom. In this idea, Sir JAMES DUNDAS, with many other sincere and virtuous patriots, signed the Covenant; though they saw afterwards, with regret, that the same association, which, with the well disposed, might have been an instrument of peace, was converted into an engine of tumult and sedition.

Account of Lord President Dundas.

ON the extinction of the monarchical government, the supreme court of judicature in Scotland, the Court of Session, was converted by OLIVER CROMWELL into a *Commission for the administration of justice*, and partly supplied by English Judges. Upon the Restoration, that Court resumed its ancient form; and among the new Judges appointed by the Sovereign, was Sir JAMES DUNDAS of Arniston, whose high character, in point of probity and natural abilities, was such as to balance the want of an education to the law as a profession. He was appointed a Judge of the Court of Session in 1662.

IN the end of the same year, CHARLES II. apprehensive of that spirit of disaffection to the government, which very generally prevailed in this country, found it necessary, with the advice of Parliament, to require all persons holding offices in Scotland, to subscribe a *Declaration*, importing that they held it unlawful to enter into Leagues and Covenants on pretence of reformation, or to take up arms against the king; and, in particular, abjuring those bonds entitled the *National* and the *Solemn League and Covenant* as illegal and seditious associations.

THIS measure was complied with by some from principle, and by others from policy. The Chancellor of Scotland being directed to require the Judges of the Court of Session to subscribe the *Declaration*, under the penalty of losing their offices, most of these,—it is to be presumed, from Conscience,—manifested an

Account of Lord President Dundas.

an easy compliance. Others, however, from the same honourable motive, refused to renounce those obligations, of which, though they regretted the abuse, they approved of the principle. Among that number was Sir JAMES DUNDAS, who refused to sign the Test-declaration, unless with a subjoined clause, importing his abjuration of the Covenant, "in so far as it had "led to deeds of actual rebellion." This qualified compliance was rejected by the Sovereign, and the recusant Judges were deprived of their offices. Their seats, however, were kept vacant for some time, in expectation, either that their scruples might be relaxed by the sense of their substantial losses, or that some medium of accommodation might be devised for adjusting the subject of difference. One expedient was proposed, which, it is probable, originated from the Sovereign himself, as it savours remarkably of his code of easy morality. This was, that such of the Judges as scrupled to give an unlimited declaration, should, for the sake of example, subscribe *simply*, as the law required, but should be allowed, in a private conversation with the King, to explain the sense in which they understood those oaths.

ON these singular terms, some of the deprived Judges were willing to redeem their offices. They repaired to London, had a private audience of his Majesty, and returned with new commissions in their pockets *. But that conciliatory measure was proposed in vain to Lord ARNISTON. He adhered resolutely and inflexibly to those principles which he esteemed right. To the solicitation of a friend, who earnestly intreated him, for his own sake, for that of his family and of the public, to be satisfied

* THEY would justify their conduct by the prudent reasoning which CICERO used to LENTULUS. "Nam neque pugnandum contra tantas opes, neque delendum, etiam si id "fieri posset, summorum civium principatum, neque permanendum in una sententia, "conversis rebus, ac bonorum voluntatibus immutatis; sed temporibus assentiendum." CIC. *Epist. ad fam. l.* 1. *ep.* 9.

fied with the propofed expedient, he returned this memorable anfwer: "I have repeatedly told you that in this affair I have "acted from confcience. I will never fubfcribe that declara- "tion, unlefs I am allowed to qualify it; and if my *fubfcription* is "to be *public*, I cannot be fatisfied that the *falvo* fhould be *latent*." Account of Lord Prefident Dundas.

His feat in the Court of Seffion was not filled up for three years; during all which time, he was affailed in vain by the folicitations both of his brethren on the Bench, and of the King's Minifters. Happy in the approbation of his own mind, and honoured with the efteem of all men of worth, he retired to his family-feat of Arnifton; and there, in the tranquil enjoyments of the country, in the gratification of a tafte for polite literature, and in the fociety of his friends, he paffed the remainder of his days.

Sir James Dundas died in the year 1679. Robert, his eldeft fon, by Marion, daughter of Robert Lord Boyd, was bred to the profeffion of the law. He reprefented the county of Edinburgh for many years in the Parliament of Scotland; and was appointed a Judge of the Court of Seffion by King William in 1689. He filled that ftation, during the period of thirty-feven years, with great honour and integrity; and before his death in 1727, had the fatisfaction of feeing his eldeft fon * fucceffively difcharging the moft important offices in the law, and though a very young man, far advanced in that fplendid career in which he was deftined to arrive at the fummit of his profeffion.

This was Robert Dundas of Arnifton, afterwards Lord Prefident of the Court of Seffion, the Father of him who is the proper fubject of this Memoir. Though in no period of his life diftinguifhed for laborious application to ftudy, he had, in his

* Born 9th December 1685. His mother was Margaret, daughter of Sir Robert Sinclair of Stevenfon.

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his earlier years, improved his mind by an acquaintance with general literature; and he gained by practice, aided by uncommon acutenefs of talents, a profound knowledge of the law.

He had been but eight years at the bar, when his reputation pointed him out as the fitteft perfon to hold the office of Solicitor-general, to which he was appointed by King George I. in 1717. The ftate of the country, recently the fcene of rebellion, and ftill fecretly fermenting with the rancour of party-contentions, was fuch, as to require, on the part of the law-officers of the Crown, the utmoft extent of political prudence; a zeal firm and fervent in its aim, but cautious in its exertions, and a humane moderation in the exercife of authority, which has ever been found more efficacious than feverity, in extinguifhing difaffection to government.

The office of Solicitor-general was preparatory to that of Lord Advocate for Scotland, to which Mr Dundas was appointed in 1720. In 1722, he was elected Member of Parliament for the county of Edinburgh; and, in that fituation, he diftinguifhed himfelf by a moft vigilant attention to all public meafures, in which the intereft of his country was concerned, and by a fteady and patriotic regard for its interefts.

On the change of Miniftry, which took place in 1725, when Sir Robert Walpole and the Argyle party came into power, Mr Dundas was removed from his office of King's Advocate, and refumed his ftation without the bar, diftinguifhed only by the honourable title of Dean of the Faculty of Advocates, till he was raifed to the Bench in 1737. For nine years, he filled the feat of an ordinary Judge of the Court of Seffion, till the year 1748, when, on the death of Mr Duncan Forbes of Culloden, he was appointed to fucceed him in the honourable and important office of Prefident of the Court.

While a barrifter, he fhone equally as a powerful pleader and an ingenious reafoner. To the quickeft apprehenfion, he joined an uncommon folidity of judgment; and embracing in his

his mind all the poſſible arguments which were applicable to his cauſe, he could, even in his unpremeditated pleadings, diſcover at once, and inſtantly attach himſelf to ſome ſtrong principle of law on which he built the whole of his reaſoning. His eloquence, though as various as the nature of the cauſe required, was conſtantly ſubſervient to his judgment; and though maſter of all the powers of expreſſion, he rarely indulged himſelf in what is properly termed declamation. A fine ſpecimen of his argumentative powers is to be found in the defence for CARNEGIE of Finhaven, on his indictment for the murder of the Earl of Strathmore. In that memorable trial, he had not only the merit of ſaving the life of the priſoner, but of eſtabliſhing a point of the utmoſt conſequence to the ſecurity of life and liberty, the power of a jury, at that time queſtioned in this country, of returning a *General Verdict* on the guilt or innocence of the perſon accuſed.

Account of Lord Preſident Dundas.

IN Scotland, though *General Verdicts* appear to have been authoriſed by the moſt ancient practice of the criminal court, it had long been cuſtomary to conſider jurymen as tied down to determine ſimply, whether the facts in the libel were *proved* or *not proved*. This change from the ancient practice is ſuppoſed, with much reaſon, to have been introduced into this country in the latter part of the reign of CHARLES II.; at a time when we find the King's Advocate ſtrenuouſly contending, in his *Syſtem of Criminal Law*, for the entire abolition of juries *. The latter was too ſtrong a meaſure, and would have been found of difficult accompliſhment; the former was of eaſier attainment, and anſwered nearly the ſame end. The accuſed perſon, to ſatisfy appearances, and for the ſhew of juſtice, was ſtill to be tried by his peers; but his guilt or innocence was rarely within their cogniſance: that was decided by the laws, or by their interpreters, the Judges; and the jury, tied down to determine ſolely on the proof of facts, was compelled to ſurrender into the hands

F 2 of

* MACKENZIE Crim. Law of Scotland, tit. 23.

Account of Lord President Dundas.

of these Judges, and thus often to sacrifice the life of a fellow-citizen, though convinced of his innocence, and earnestly desirous of his acquittal.

THUS matters stood till the celebrated trial of CARNEGIE of Finhaven, who, had the powers of a Scottish jury remained thus circumscribed, must have suffered the punishment due to the foulest malefactor, for an act on which it is scarcely possible to affix a taint of blame *. The Court had found the facts in the indictment *relevant to infer the pains of law*. The proof of those facts was as clear as noon-day. There remained no hope for the prisoner, unless the jury should be roused to assert a right which they had long relinquished, and vindicate the privilege of deciding on the guilt or innocence of the accused. And this great point was gained by the powerful eloquence of the prisoner's counsel. The jury found the prisoner *Not Guilty*. From that time, the right of a Scottish jury to return a *General Verdict*, is acknowledged to be of the very essence of that institution.—And GOD forbid! a period should ever arrive, when that most valuable of rights shall again be called in question.

As a Judge, Lord ARNISTON distinguished himself no less by the vigour of his talents, and his knowledge of the laws, than by his strict principles of honour and inflexible integrity. His own idea of the character, both of a Lawyer and of a Judge, remains, penned by himself, in that admirable eulogium on Lord NEWHALL, which stands upon the records of the Faculty of Advocates; and those who yet remember the man of whom we now speak, know that many of those various

* JAMES CARNEGIE of Finhaven, was tried before the Court of Justiciary in Scotland, for the murder of CHARLES Earl of Strathmore, in 1728. At a meeting in the country, where the company had drank to intoxication, CARNEGIE of Finhaven having received the most abusive language, and sustained a personal outrage of the grossest nature, from LYON of Bridgeton, drew his sword, and staggering forward to make a pass at Bridgeton, killed the Earl of Strathmore, a person for whom he had the highest regard and esteem, and who unfortunately came between him and his antagonist, apparently in the view of separating them.

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ous talents and accomplishments which he there applied to another, were in a peculiar manner his own.

THIS eminent and truly respectable man, after a life devoted to the public good, died in the 68th year of his age, on the 26th day of August 1753.

HE left by his first wife, ELIZABETH, the daughter of ROBERT WATSON, Esq; of Muirhouse, a son, ROBERT, the late President of the Court of Session, and two daughters. By his second wife, ANNE, the daughter of Sir ROBERT GORDON of Invergordon, Baronet, he left five sons and a daughter. Of this last marriage, is the Right Hon. HENRY DUNDAS of Melville, Treasurer of the Navy; whose various and splendid abilities, directed at first to the profession of the law, and eminently displayed while he held the offices of Solicitor-general and Lord Advocate for Scotland, are now equally distinguished in the Legislative Assembly, and in the Councils of his Sovereign.

ROBERT DUNDAS of Arniston, late Lord President of the Court of Session, was born on the 18th of July 1713. He received the earlier parts of his education under a domestic tutor, and afterwards pursued the usual course of academical studies in the University of Edinburgh. In the end of the year 1733, he went to Utrecht, where the lectures on the Roman Law were at that time in considerable reputation. He remained abroad for four years; and, during the recess of study at the University, he spent a considerable time at Paris, and in visiting several of the principal towns of France and the Low Countries.

RETURNING to Scotland in 1737, he was called to the bar in the beginning of the following year; and, in his earliest public appearances, gave ample proof of his inheriting, in their utmost extent, the abilities and genius of his family. His eloquence was copious and animated; in argument, he displayed a wonderful fertility of invention, tempered by a discriminating judgment,

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judgment, which gave, even to his unpremeditated harangues, a methodical arrangement; in consultation, he possessed a quickness of apprehension beyond all example; and his memory, which was most singularly tenacious, enabled him to treasure up, and to produce instantaneously, every case or precedent which was applicable to the matter before him.

THUS liberally endowed by nature with every requisite to eminence in his profession, he had the honour of being appointed Solicitor-general for Scotland in September 1742, at the early age of twenty-nine. This important office he held only for four years. He had obtained it through the favour of the Carteret administration, which was then in power; but, on the change of Ministry, which took place in 1746, when the Pelham party regained its influence in the Cabinet, he, together with the other friends of the former Ministry, resigned their offices.

BUT the high consideration in which he then stood with his brethren at the bar, was not diminished by the loss of an office dependent on ministerial favour. In the same year, 1746, he was elected Dean of the Faculty of Advocates, and continued to preside over that respectable body till his elevation to the Bench in 1760.

IN the beginning of the year 1754, Mr DUNDAS was elected Member of Parliament for the county of Edinburgh; and, in the following summer, he was appointed his Majesty's Advocate for Scotland.

IN Parliament, the share which Mr DUNDAS took in public business, and his appearances on many interesting subjects of discussion, which occurred in that important period during which he sat in the House of Commons, were such as fully to justify the character he had already attained for talents and ability. Such was the complexion of the times, and so high the tide of party, that it was perhaps impossible for human wisdom to have pointed out a line of political conduct which could

could entirely exempt from cenfure. The Lord Advocate fhared with the reft of his party in the cenfure of thofe who followed an oppofite plan of politics; but of him it may certainly with truth be affirmed, that in no inftance was he ever known to fwerve from his principles, or to act a part in which he had not the countenance of many of the firmeft friends to the intereft of their country.

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THE oppofition which the Lord Advocate gave to the eftablifhment of a *Militia* in Scotland, afforded a topic of blame to a great party in this country who warmly fupported that meafure. But when the queftion is difpaffionately viewed, it will appear to be one of thofe doubtful points, on which the wifeft men and the beft patriots may entertain oppofite opinions.

THE apprehenfion of an invafion from France, which, from the commencement of the war in 1756, had been repeatedly threatened upon the fouthern coafts of the ifland, occafioned the paffing of various acts of the Legiflature, for the eftablifhment and regulation of the militia forces through the feveral counties of England. In the beginning of the year 1760, the fame apprehenfion had extended to Scotland. The fmall armament under THUROT committing acts of depredation on the weftern coafts with perfect impunity, began to excite a very alarming fenfe of the defencelefs fituation of the country. Meetings were held in many of the counties, and refolutions paffed for applying to Parliament to procure the eftablifhment of a militia in Scotland, upon a fimilar plan with that which now fubfifted in England. The political emergency appeared the fame through the whole kingdom. The Scots were alike fenfible to the danger of their lives and properties as their neighbours of the fouth. They juftly confidered themfelves as ftanding, by the *Treaty of Union*, on an equal footing with the Englifh, with regard to all the privileges of Britifh fubjects; and while the inhabitants of one part of the ifland were furnifhed with

Account of Lord Prefident Dundas.

with arms for their own defence, it feemed but juftice to allow the other the fame means of fecurity and protection.

These arguments, which are of a general nature, or at beft applicable only to a temporary emergency, and to an apprehenfion rather of eventual than of immediate danger, were anfwered by reafons drawn from the ftate of the country, from the character of the people, and from a view of thofe confequences which muft have been the certain refult of the propofed eftablifhment. Scotland, it was argued, is far behind her fifter-kingdom in the œconomical arts of induftry. The genius of the people, particularly in the northern parts, is averfe to labour and to all the arts of peace. But the Scots are warlike from conftitution, and the military character of the nation has been high in all ages. The artificial habits of difcipline and regular exercife, are little neceffary in a country, where men are by nature foldiers, attached with enthufiafm to their native land, and prompt to defend themfelves with fpirit upon the flighteft alarm of danger. But they need excitement to the arts of induftry. Agriculture is, in many diftricts, fhamefully neglected. Manufactures, through the whole country, are yet in their infancy. The employment of our labourers can neither be fpared from their fields, nor of our mechanics from their looms, their forges, or their anvils. To offer to thofe who are naturally little difpofed to induftry, fuch allurements to idlenefs as a national militia would prefent, would be, in the higheft degree, impolitic and ruinous to the country.

Thus, it appears, that the fcheme for the eftablifhment of a militia in Scotland, admits of very oppofite views; and men of candour, equally endowed with good fenfe, and equally patriotic, may be fuppofed, as was certainly the cafe, to have formed different opinions on the fubject. What part the Lord Advocate of Scotland, who, by his office, is one of the chief guardians of the ftate, and bound by duty to a watchful attention in all matters which regard the intereft of his country, ought to

Account of Lord Prefident Dundas.

to have taken in that meafure, it would be prefumption in any man to pronounce with confidence, while he muft admit, that opinions, equally weighty and refpectable, are found on either fide of the queftion.

It is not to be denied, that arguments of a very illiberal nature were urged in Parliament by a few Members, who, with a mean and narrow fpirit, reproached this country with difaffection to Government, and inculcated the danger of allowing the ufe of arms to thofe who had recently employed them in rebellion. It was no wonder that afperfions of this nature called forth the moft animated, noble and fpirited defence of their country's honour from feveral of the Scottifh Members, who perhaps contended the more keenly in behalf of that meafure, that they faw it oppofed from fuch unworthy motives. But the queftion, viewed without prejudice, remains ftill difputable; and the arguments of the Lord Advocate againft the eftablifhment of a militia in Scotland, were founded on the great principles of national expediency, and a regard for what appeared to him the real and fubftantial interefts of the country.

On the 14th of June 1760, Mr Dundas was appointed Prefident of the Court of Seffion. This was the æra of the fplendour of his public character. Invefted with one of the moft important trufts that can be committed to a fubject, the fuperintendence and regulation of the higheft judicature of his country, he acquitted himfelf of that truft, during the twenty-feven years in which he held it, with fuch confummate ability, wifdom and rectitude, as muft found a reputation as durable as the national annals, and tranfmit his memory with honour to all future times.

At his firft entry upon office, the public, though well affured of his abilities, was doubtful whether he poffeffed that power of application and meafure of affiduity, which is the firft duty

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of the ſtation that he now filled. Fond of ſocial intercourſe, and of late engaged in a ſphere of life where natural talents are the chief requiſite to eminence, he had hitherto ſubmitted but reluctantly to the habits of profeſſional induſtry. But it was ſoon ſeen, that accidental circumſtances alone had prevented the development of one great feature of his character, a capacity of profound application to buſineſs. He had no ſooner taken his ſeat as Preſident of the Seſſion, than he devoted himſelf to the duties of his office, with an ardour of which that Court, even under the ableſt of his predeceſſors, had ſeen no example, and a perſeverance of attention which ſuffered no remiſſion to the lateſt hour of his life.

Of all the grievances to which a free people can be ſubjected, one of the heavieſt and moſt ſevere is the tediousneſs of judicial procedure, that delay of juſtice which makes often oppreſſion itſelf more tolerable than the means to be purſued for obtaining its redreſs. Senſible of this truth, and determined to remedy (in as far as material juſtice would permit) ſo great an evil, the Preſident applied himſelf immediately to the determination of a long arrear of law-ſuits, which, though in their laſt ſtage, and ripe for judgment, had hung upon the rolls of the Court during the period of five preceding ſeſſions. Theſe, in the courſe of the ſummer-ſeſſion 1760, and in the firſt month of the next ſeſſion, were all decided, while the current buſineſs of the term was likewiſe diſpatched; and thus a load, which had been accumulating during two years and a half, was cleared away in the ſpace of three months. The *Long Roll*, which had never been purged ſince the inſtitution of the Court, and of which the very name was of evil augury, was thus annihilated at once; nor was it ever revived while Mr Dundas ſat in the Preſident's chair.

The primary cauſe of this great reform in the diſpatch of buſineſs, is certainly to be found in the uncommon power of his

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his own mental abilities. Amidft that multiplicity of fuits with which the Court of Seffion is at times overwhelmed, no party was ever heard to complain that the Prefident had treated his caufe fuperficially, or with an imperfect intelligence of the arguments which fupported it. But the truth was, he often drew his knowledge of thofe arguments, lefs from the information of the counfel than from the ftorehoufe of his own mind; for it was peculiar to him, that he could make himfelf thoroughly mafter of a caufe, and form the foundeft judgment of its merits, from the fimple perufal of the ftate of facts. His memory enabling him to retain thefe facts with the utmoft eafe, he could, in the courfe of a very few hours, dedicated to the perufal of the cafes, prepare himfelf upon the daily bufinefs of the Court. Stimulated by his example, the other Judges exerted all their powers of application; and thus the machine of juftice moved with a conftant and equal celerity, while his regulating influence operated on all its parts.

But if the affiduity and diligence of Judges in ftudying the caufes that come before them, is the firft requifite towards the difpatch of bufinefs, the next effential concern is, that thefe caufes fhall be decided with brevity, and that the time which is appropriated to giving judgment be not confumed in fuperfluous reafonings, or that fpecies of wavering debate, which equally retards procedure, and diminifhes the refpect and dignity of the Court. There is no doubt that the reafoning of Judges upon the Bench, is of excellent effect, when feafoned by that difcretion which is fitted to imprefs an audience with reverence for the wifdom and folemnity of the tribunal. And of this we have daily examples in the Supreme Court of this country. The arguments of the Judges are often replete with inftruction to the bar. In many cafes, to which, from their circumftantiate nature, neither the written nor the confuetudinary law is directly applicable, thefe are the *Refponfa Prudentum* which fup-

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ply that unavoidable deficiency. They are, moreover, a criterion to the public, both of the abilities of Judges, and of their attention to the duties of their office. But ftill, it muft be admitted, that there is much danger in allowing too great latitude to judicial reafonings. Befides the delay of bufinefs, there is a hazard that that warmth of argument, againft which even the wifeft and moft difpaffionate of men cannot at all times guard themfelves, fhould diminifh the reverence due to the Court, and even the authority of its decifions; for thofe judgments can affuredly have but little weight which are known to be the refult of a war of contradictory ideas. In a tribunal compofed of many Judges, there muft of courfe be a frequent diverfity of opinion; but it is not always defirable that the grounds of thofe different opinions fhould be publicly canvaffed. It is with the wifdom of a Court, as it is with perfonal beauty, (the obfervation of one of the ableft judges of human nature*) the form upon the whole, when furveyed at its proper diftance, may be confummately graceful; but it is not expedient to examine it by too near an approach, or to analyfe too minutely its particular features.

Such were known to be the fentiments of that great Judge, whofe character we are now attempting to delineate; and correfponding to thefe fentiments was his own conduct upon the Bench. He very rarely entered into a laboured argument on the whole grounds of a caufe; much lefs into an examination or confutation of the opinions delivered by his brethren. He limited himfelf to a fhort and folemn enunciation of his own opinion, which he generally fupported by a very few reafons, on which he apprehended the decifion ought to reft. His manner of fpeaking was firm and authoritative; his language forcible, though unadorned in its ftructure; and, feeking not to pleafe, but to convince, he difregarded thofe graces of elocution

* Clarendon.

tion which the orator may frequently find of uſe to palliate error, but which the Judge needs ſeldom to employ, who is deſirous only of inculcating truth.

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He maintained, with great ſtrictneſs, all the forms of the Court in the conduct of buſineſs. Theſe he wiſely conſidered as eſſential, both to the equal adminiſtration of juſtice, and as the outworks which guard the law againſt thoſe too common, but moſt unworthy artifices which are employed to proſtitute and abuſe it.

To the bar, he conducted himſelf with uniform attention and reſpect. He liſtened with patience to the reaſonings of the Counſel. He never anticipated the arguments of the pleader, nor interrupted him with queſtions to ſhew his own acuteneſs; but left every man to ſtate his cauſe in his own way: nor did he ever interfere, unleſs to reſtrain what was either manifeſtly foreign to the ſubject, or what wounded, in his apprehenſion, the dignity of the Court. In this laſt reſpect he was moſt laudably punctilious. He never ſuffered an improper word to eſcape, either from the tongue or pen of a counſel, without the ſevereſt animadverſion; and ſo acute was that feeling which he was known to poſſeſs of the reſpect that was due to the Bench, that there were but few occaſions when it became neceſſary for him to expreſs it.

There were indeed other occaſions, on which his feelings were moſt keenly awakened, and on which he gave vent to a becoming ſpirit of indignation. He treated with the greateſt ſeverity every inſtance, either of malverſation in the officers of the law, or of chicanery in the inferior practitioners of the Court. No calumnious or iniquitous proſecution, no attempt to pervert the forms of law to the purpoſes of oppreſſion, ever eluded his penetration, or eſcaped his juſt reſentment.

Thus, perpetually watchful, and earneſtly ſolicitous to maintain both the dignity and the rectitude of that Supreme Tribunal over

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over which he prefided, the influence of thefe endeavours extended itfelf to every inferior court of judicature; as the motion of the heart is felt in the remoteft artery. In reviewing the fentences of inferior judges, he conftantly expreffed his defire of fupporting the juft authority of every rank and order of Magiftrates; but thefe were taught, at the fame time, to walk with circumfpection, to guard their conduct with the moft fcrupulous exactnefs, and to dread the flighteft deviation from the narrow path of their duty.

WITH thefe endowments of mind, and high fenfe of the duties of his office, it is not furprifing, that amidft all the differences of fentiment which the jarring interefts of individuals, or the more powerful influence of political faction, give rife to, there fhould be but one opinion of the character of this eminent man, which is, That from the period of the inftitution of that Court over which he prefided, however confpicuous in particular departments might have been the merit of fome of his predeceffors, no man ever occupied the Prefident's chair, who combined in himfelf fo many of the effential requifites for the difcharge of that important office.

BUT it is not the intention of the writer of this account to prefent a faultlefs picture. Nothing, in fact, is of fo little value as indifcriminate panegyric; nothing fo empty and infignificant as *his* praife who fhews that he is blind to imperfections. If we allow the merits of this great man, in poffeffing, in their utmoft extent, the moft effential requifites for the ftation which he filled, it is but a fmall derogation from the confeffed eminence of his character, when we acknowledge a deficiency in fome fubordinate qualities.

OF thefe, what was chiefly to be regretted, and was alone wanting to the perfection of his mental accomplifhments, was, that he appeared to give too little weight or value to thofe ftu-

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dies which are properly termed literary. This was the more remarkable in him, that, in the early period of his life, he had profecuted himfelf thofe ftudies with advantage and fuccefs. In his youth, he had made great proficiency in claffical learning; and his memory retaining faithfully whatever he had once acquired, it was not unufual with him, even in his fpeeches on the Bench, to cite, and to apply with much propriety the moft ftriking paffages of the ancient authors. But for thefe ftudies, though qualified to fucceed in them, it does not appear that he ever poffeffed a ftrong bent or inclination. If he ever felt it, the weightier duties of active life, which he was early called to exercife, precluded the opportunity of frequently indulging it; and perhaps even a knowledge of the fafcinating power of thofe purfuits, in alienating the mind from the feverer, but more neceffary occupations, might have inclined him at laft to difrelifh from habit, what it had taught him at firft to refift from principle.

THAT this principle was erroneous, it is unneceffary to confume time in proving. It is fufficient to fay, that as jurifprudence can never hope for any material advancement as a fcience, if feparated from the fpirit of philofophy, fo that fpirit cannot exift, independent of the cultivation of literature.

THAT the ftudies of polite literature, and an acquaintance with the principles of general erudition, while they improve the *fcience*, add luftre and dignity to the *profeffion* of the law, cannot be denied. So thought all the greateft lawyers of antiquity. So thought, among the moderns, that able Judge and moft accomplifhed man, of whofe character we have traced fome imperfect features, Lord Arnifton, the Father of the late Lord Prefident; of which his inaugural oration, as it ftands upon the records of the Faculty of Advocates, bears ample teftimony *.

HIS

* "FROM his firft entry into the Faculty, he could fay he knew, and obferved it with "pleafure, as it tended greatly to their honour, that there was no fcience, or part of po- "lite

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His fon, it is true, afforded a ftrong proof, that the force of natural talents alone may conduct to eminence and celebrity. He was rich in native genius, and therefore felt not the want of acquired endowments. But in this he left an example to be admired, not imitated. Few inherit from nature equal powers with his; and even of himfelf it muft be allowed, that if he was a Great Man without the aids of general literature, or of cultivated tafte, he muft have been ftill a greater, had he availed himfelf of thofe lights which they furnifh, and that improvement which they beftow.

This moft ufeful and valuable life was terminated on the 13th of December 1787. His laft illnefs, which, though of fhort continuance, was violent in its nature, he bore with the greateft magnanimity. He died in the 75th year of his age, in the perfect enjoyment of all his faculties; at a time, when his long fervices might have juftly entitled him to eafe and repofe, but which the ftrong fenfe of his duty would not permit him to feek while his power of ufefulnefs continued; at that period, in fhort, when a wife man would wifh to finifh his courfe; too foon indeed for the public good, but not too late for his own reputation.

He left by his firft wife, Henrietta Baillie, the daughter of Sir James Carmichael-Baillie of Lamington, four daughters.

" lite and ufeful learning, for the knowledge of which fome in the Faculty were not di-
" ftinguifhed, perhaps equally with thofe who made the feveral parts of thofe fciences
" their principal and particular profeffion. And he hoped he would be excufed for re-
" commending to them, and to all young gentlemen that might afterwards enter among
" them, to be at pains to maintain and preferve that character and reputation they had
" long held, and ftill poffeffed, not only for the knowledge of the Civil or Roman and
" Municipal Laws, and the conftitution of their country, but of the other valuable
" branches of learning, that are requifite to accomplifh and adorn the character of gen-
" tlemen, and were indeed neceffary to render them completely qualified for the exercife
" of their profeffion." *Records of the Fac. of Adv.* Nov. 3. 1748.

daughters. By his ſecond wife, JANE, the daughter of WILLIAM GRANT, Eſq; of Preſtongrange, one of the Senators of the College of Juſtice, he left four ſons and two daughters. Of theſe, the eldeſt ſon is ROBERT DUNDAS, Eſq; now of Arniſton, his Majeſty's Solicitor-general for Scotland*; whom his country ſees with pleaſure the heir of the abilities of his family, already high in the eſteem of all his cotemporaries, and purſuing with ardour the honourable path which is marked by the footſteps of his anceſtors.

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* SINCE the date of this Memoir, Mr DUNDAS of Arniſton has been appointed his Majeſty's Advocate for Scotland, October 31. 1789. The late Lord Preſident DUNDAS was ſucceeded in that office by Sir THOMAS MILLER of Glenlee, who, to the eminent loſs of the public, and the ſincere regret of all who knew him, died on the 27th day of September 1789. Upon that event, ILAY CAMPBELL, Eſq; then Lord Advocate, was promoted to the Preſidency of the Court of Seſſion, and was ſucceeded in the office of Lord Advocate by Mr DUNDAS.

II. Account *of Sir* Alexander Dick, *Bart. of Prestonfield, late President of the Royal College of Physicians of Edinburgh, and* F. R. S. Edin.

[*Read by Dr* Duncan, *now Professor of the Theory of Medicine in the University of Edinburgh, March* 16. 1789.]

Sir Alexander Dick of Prestonfield, was born on the 23d of October 1703. He was the third son of Sir William Cunningham of Caprington, by Dame Janet Dick, the only child and heiress of Sir James Dick of Prestonfield. While his two elder brothers succeeded to ample fortunes, the one as heir to his father, the other to his mother, the provision made for a younger son was not sufficient to enable him to live in a manner agreeable to his wishes, without the aid of his own exertions. His inclination led him to make choice of the profession of Medicine; and after being instructed in the preliminary branches of education at Edinburgh, he began his academical studies in the science of Physic, at the University of Leyden, under the celebrated Boerhaave, at that time the most eminent Medical Professor in Europe. After having completed the usual academical course under Boerhaave and his colleagues, he obtained the degree of Doctor of Medicine from the University of Leyden, on the 31st of August 1725; and, upon that occasion, he published an inaugural dissertation *De Epilepsia*, which did him much credit. Not long after this, he returned to his native country, and had the honour of receiving a second diploma for the degree of Doctor of Medicine, which was conferred upon him by the University of St Andrews, on the 23d of January 1727; and on the 7th of November

vember of the ſame year, he was admitted a Fellow of the Royal College of Phyſicians of Edinburgh.

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But after Dr Cunningham (for at that time he bore the name of his father) had received theſe diſtinguiſhing marks of attention at home, he was ſtill anxious to obtain farther knowledge of his profeſſion by the proſecution of his ſtudies abroad. With this intention, he made the tour of Europe; and although medicine was uniformly his firſt and principal object, yet other arts and ſciences were not neglected. During this tour, he reſided for a conſiderable time in Italy; and there an elegant claſſical taſte, and extenſive knowledge of the hiſtory and antiquities of the country, could not fail to afford him a very high degree of gratification.

Upon his return to Britain, Mr Hooke, a gentleman with whom he had formed an intimate friendſhip, and who poſſeſſed a large fortune in Pembrokeſhire, perſuaded him to ſettle as a Phyſician in that country. For ſeveral years he practiſed medicine there with great reputation and ſucceſs, and was much reſpected and admired, both as a Phyſician and a Man. But his immediate elder brother Sir William Dick, dying without iſſue, he ſucceeded to the family-eſtate and title, aſſuming, from that time, in terms of the patent and entail of that eſtate, the name and arms of Dick. Very ſoon after the death of his brother, he left Pembrokeſhire, and fixed his reſidence at the family-ſeat of Preſtonfield in Mid Lothian, little more than a mile from the city of Edinburgh.

Although he now reſolved to relinquiſh medicine as a lucrative profeſſion, yet, from inclination, he ſtill continued to cultivate it as an uſeful ſcience. With this view, he ſupported a friendly and intimate correſpondence with the Phyſicians of Edinburgh; and he ſoon diſtinguiſhed himſelf, by paying particular attention to the buſineſs of the Royal College, among the liſt of whoſe members his name had been inrolled at a very early period of his life. In the year 1756, he was unani-

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moufly chofen Prefident of the College; and as his fellow-members were fully convinced of his zeal, as well as of his abilities, they afterwards elected him to that office for feven years fucceffively. It was their earneft wifh that he fhould have continued ftill longer as their head; but this he pofitively declined, as he thought that he fhould thus deprive other gentlemen of a dignity, to which, from their merit, they were well entitled. But after his refignation of the office of Prefident, his attachment to the College, and his earneft endeavours to promote its intereft, continued unabated. He not only contributed liberally towards the building of a hall for their accommodation, but ftrenuoufly exerted himfelf in promoting every undertaking in which he thought that the honour or intereft of the College was concerned. As a teftimony of the fenfe which his fellow-members entertained of his fervices, a portrait of him was, by their unanimous fuffrages, hung in their hall; a mark of diftinction which has never been beftowed, either before or fince that time, upon any other member.

BUT the College of Phyficians were not the only fet of men who were benefited by his exertions. He was long diftinguifhed as a zealous and active member of the Philofophical Society of Edinburgh. And when they refolved to join their influence as a body, in feconding an application to the Crown from the Univerfity, for the eftablifhment of a new Society under Royal patronage, and on a more extended plan, having for its object the cultivation of every branch of fcience, erudition and tafte, he had an active hand in procuring the eftablifhment of this inftitution. And accordingly, when his Majefty was gracioufly pleafed to grant a charter for incorporating the Royal Society of Edinburgh, the name of Sir ALEXANDER DICK ftands inrolled as one of the firft in the lift. For many years, he difcharged the duties of a faithful and vigilant Manager of the Royal Infirmary of Edinburgh. It was his conftant endeavour to render that eftablifhment at once fubfervient to the relief

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lief of the diſtreſſed, and to the advancement of medical education. And while he ſhewed himſelf a ſincere friend to the poor, he was alſo remarkable for the countenance and encouragement which he gave to modeſt merit, particularly among the ſtudents of medicine. Indeed, poſſeſſing a high degree of public ſpirit, he took an active ſhare in promoting every undertaking which he thought would be beneficial, either to his country in general, or to the city of Edinburgh in particular. To him, its inhabitants are much indebted for many excellent high roads in the neighbourhood; and hardly one internal improvement was ſuggeſted or executed, during his reſidence at Preſtonfield, which he was not inſtrumental in promoting, with an activity which did him the higheſt honour.

WHEN the ſeeds of the true rhubarb were firſt introduced into Britain by the late Dr MOUNSEY of Peterſburg, he not only beſtowed great attention on the culture of the plant, but alſo on the drying of the root, and preparing it for the market. The ſucceſs in theſe particulars was ſo great, that the Society in London for the encouragement of arts and commerce, preſented him, in the year 1774, with a gold medal, which is inſcribed to Sir ALEXANDER DICK, Bart. for the beſt ſpecimen of Britiſh rhubarb.

Sir ALEXANDER was twice married, and has left children by both marriages. In April 1736, he married his couſin Miſs JANET DICK, the daughter of ALEXANDER DICK, Eſq; merchant in Edinburgh, and repreſentative of the family of Sir WILLIAM DICK of Braid. By her he had five children, but of theſe two daughters only ſurvived him. In March 1762, he married Miſs MARY BUTLER, the daughter of DAVID BUTLER, Eſq; of Pembrokeſhire. By this lady, who ſurvived him, he had ſeven children, of whom three ſons and three daughters are ſtill alive.

IT would be a difficult matter to ſum up his character in a few words. But it may with juſtice be ſaid, that while he was

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ſteady in the purſuit of every object which engaged his attention, his conduct in every tranſaction through life, was marked with the ſtricteſt honour and integrity. This diſpoſition, and this conduct, not only led him to be conſtant and warm in his friendſhip to thoſe with whom he lived in habits of intimacy, but alſo procured him the love and eſteem of all who really knew him. Notwithſtanding the keenneſs and activity of his temper, yet its ſtriking features were mildneſs and ſweetneſs. He was naturally diſpoſed to put the moſt favourable construction on the conduct and actions of others. This was both productive of much happineſs to himſelf, and of general benevolence to mankind. And that ſerenity and cheerfulneſs which accompanied his conduct through life, were the attendants even of his laſt moments; for, on the 10th of November 1785, he died with a ſmile upon his countenance. Although he had already paſſed the 82d year of his age, a period at which the faculties both of mind and body have in general ſo far failed, that death is rather to be wiſhed for than otherwiſe, yet not only his judgment, but his ſpirit for exertion, ſtill remained unimpaired. His death, therefore, even at that advanced age, was a great loſs to ſociety.

III. Ac-

III. Account *of the Right Honourable Sir* Thomas Miller *of Glenlee, Bart. Lord President of the Court of Session, and* F. R. S. Edin.

[*Read by* David Hume, *Esq; Advocate,* F. R. S. Edin. *and Professor of Scots Law in the University of Edinburgh, Dec.* 21. 1789.]

IT has often occurred to me, as a hard circumstance in the lot of those who follow the active employments of life, that however great their eminence, however useful their labours, nay, however rare and excellent their talents, the remembrance of them dies among their countrymen at large, almost as soon as they themselves are gone; and even with those of their own professions scarcely survives for more than a single generation. The records of the Royal Society are therefore in this respect valuable, that they afford the means of rescuing from oblivion, those of our Members who, by their professional eminence and services, have merited the gratitude and remembrance of their country, though their line of life did not permit them to attain distinction of another kind, by any literary work or discovery in science.

I thought it would be universally felt and allowed, that the late Sir Thomas Miller, (at one time a Vice-President of this Society), most justly fell under the above description of a singularly useful man, and fit to be commemorated. And in this persuasion, I have prepared a short account of him, now to be submitted to your consideration.

Sir

Account of Lord Prefident Miller.

Sir THOMAS MILLER of Glenlee, late Lord Prefident of the Court of Seffion, was the fecond fon of WILLIAM MILLER, writer to the Signet, who was himfelf the fecond fon of MATTHEW MILLER of Glenlee, and fucceeded to that eftate, along with the lands of Barfkimming, on the death of his elder brother.

Sir THOMAS was born on the 3d of November 1717. He received the firft rudiments of his education at Glafgow, and afterwards went through the ufual courfe of academical ftudies in the Univerfity of that place; where he acquired a relifh of the purfuits of literature and fcience, that never forfook him, and efpecially a fondnefs for the Greek and Roman claffics, which, even in the bufieft periods of his life, he occafionally found opportunities to indulge. HORACE was almoft his conftant companion; and even in his laft years, after his promotion to the moft laborious office in the law, HOMER, during a vacation, was often on his table.

ANOTHER branch of knowledge for which he there imbibed an early predilection, was that of Ethics, or Moral Philofophy. This he had the advantage of ftudying under the celebrated Dr HUTCHESON, of whom he was a favourite pupil. The warmth of eloquence with which this Philofopher poured forth his lectures, attached to him extremely all thofe of his hearers, who had any liking to the fubject he treated, or were fufceptible of being moved; and Mr MILLER, in particular, contracted not only a high admiration of his talents, but fuch love to him as a man, that long after his death, and when he himfelf had grown old, he could not mention his name but in terms of gratitude and veneration, equal to thofe in which the difciples of SOCRATES fpoke of their mafter. Like SOCRATES too, Dr HUTCHESON taught his difciples to value Ethics beyond all other fciences; and with Mr MILLER this preference was fo ftrong, that he ufed habitually in converfation, when diftinguifhing it from the reft, to give it the appellation of *Philofophy*.

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HAVING thus, by the improvement of his tafte, and the acquifition of a philofophic fpirit, made the beft preparation for eminence in any liberal employment, he decided for the Bar, the profeffion to which thofe accomplifhments lend the moft diftinguifhed luftre of any, and where they moft materially contribute to the advancement of the perfon poffeffed of them. For fome time he had hefitated between this profeffion and his father's; and it is faid to have been in a great meafure owing to the ftate of his health, that he gave up thoughts of the latter.

WHEN he had refolved on going to the Bar, he fixed his refidence at Edinburgh, and devoted himfelf to the ftudy of the law, with that zeal and earneftnefs with which, during his whole life, he was remarkable for following every object that had once determined his choice *. Yet with all his diligence in this neceffary occupation, as the turn of his mind led him to no bafe or trifling purfuits, he was able to find time, and neglected not to employ it, for cultivating the humaner and more liberal ftudies. Even at this time, he continued to read the claffics extenfively, particularly the better *Greek* authors, having for his affiftant the late Mr GEORGE MUIRHEAD, afterwards Profeffor of Humanity at Glafgow, whofe reputation as a claffical fcholar is well known.

IN the month of July 1742, he was called to the Bar. Where he had not long continued, before the moft favourable opinion came to be entertained, among the perfons beft entitled to judge, of the proficiency he had made in the knowledge of the law, and of his excellent qualifications, both for counfel and debate. His elocution was copious and eafy; his felection of argument judicious, and his mode of prefenting it, in the higheft degree perfpicuous and plain; and he accompanied it with a manner of delivery fo weighty and fervent, as carried home to the

 hearer

* HIS ufual hour of going to bed at this period was four of the morning.

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hearer the impreſſion of his own belief in the doctrines he maintained. Men there might perhaps be in the profeſſion, more eminent for invention of topics in a deſperate cauſe, or who ſhowed more verſatility of genius in placing the ſame buſineſs in different lights, or turning it into all variety of ſhapes; but there was none who better underſtood the ſtrength of a good or a tenable cauſe, or took his ground in one of that deſcription with more judgment and diſcretion, or uſed its advantages to better purpoſe. Having found the ſoundeſt or moſt favourable part of his client's plea, *that* he attached himſelf to, and on *it* exerted all his ſtrength; throwing aſide, with juſt and proper confidence, all the more doubtful points and weaker conſiderations in the cauſe. Captious and quibbling argument indeed, and all perverſion of an adverſary's words or meaning, he held to be as foreign to the lawyer's duty, as they are derogatory to the honour of the Court where they are heard; nor could he, on any occaſion, be prevailed on to attempt the aiding of his cauſe, in a manner ſo inconſiſtent with his own feelings of what was right and proper.

No wonder then, that thus qualified, and regulated by ſentiments ſo reſpectable, he quickly roſe to a high degree of employment in his profeſſion, though he had among his cotemporaries, for rivals in the public favour, men of the greateſt acuteneſs and ſplendour of parts.

Hence alſo he, at an early period of life, entered the career of public offices and honour in the department of the law.

In the year 1748, on the new arrangement of the office of Sheriff, (which has been attended with ſo many ſalutary conſequences) he was pitched upon as a fit perſon for one of thoſe appointments. The county which Government had deſtined for him, was that of Inverneſs, in thoſe times of recent diſorder and rebellion, accounted the moſt important of any, and what required the ſteadieſt and moſt able ſuperintendence. But this appointment, though more advantageous, he declined; becauſe his

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his friend the Earl of SELKIRK had recommended him to Government for the ſtewartry of Kirkcudbright, and it had been underſtood between him and the Earl that he was to accept it.

THE duties of this office he performed with great punctuality, and to the entire ſatisfaction of the diſtrict entruſted to his charge; and he continued to hold it till the year 1755, when he reſigned, and was named Solicitor of Exciſe—an office in thoſe days generally held by a lawyer.

IN the year 1759, on the promotion of Mr PRINGLE (afterwards Lord ALEMORE) to the Bench, he reaped the fruit of the public favour, in being appointed his Majeſty's Solicitor-General for Scotland.

IN the year 1760, he ſucceeded the late Preſident DUNDAS as his Majeſty's *Advocate* for Scotland; and in the following year, he was choſen to ſerve in Parliament for the burgh of Dumfries.

WHILE in theſe ſtations, Mr MILLER, whoſe modeſty and diſcretion were equal to his ability, did not think it ſo much incumbent on him to take an active ſhare in the debates of the Aſſembly, as to regulate his voice according to his opinion of the public good. The ſingle occaſion that called him up as a ſpeaker, was indeed of a very intereſting kind, and became a ſignal proof of the independence of his ſpirit, and ſincere concern in the grandeur and proſperity of the Britiſh empire. This was the repeal of the American ſtamp act; a meaſure in which Mr MILLER's ſagacity foreſaw the miſerable train of conſequences that have ſince enſued from it, and which, though ſupported by all the influence of the then Miniſtry, he accordingly both voted againſt, and gave his reaſons to the Houſe for oppoſing:—A moſt reſpectable and truly patriotic piece of conduct, and of which he reaped a juſt, but unlooked for reward, in the friendſhip and eſteem of the Marquis of ROCKINGHAM; who, however loath to have an opponent in the principal ſervant of the Crown for Scotland, yet, ſatisfied that he had taken

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this line from the pureſt and moſt diſintereſted motives, continued him in his public ſtation, and ever after honoured him with his particular attention.

In the year 1766, on the death of Lord Minto, he was appointed Lord Justice Clerk; which office both beſtows the Preſidency of the higheſt Criminal Tribunal, and a ſeat as an ordinary Judge in the ſupreme Civil Court.

In theſe high ſtations, he fully juſtified the choice that had been made of him, and ſoon, by his ſcrupulous attendance on the Court, and aſſiduous labour in the diſpatch of buſineſs, gained a high place in the eſteem and confidence of the public, as a man deeply impreſſed with the importance of his duties, and actuated by a warm and ſteady zeal conſcientiouſly to diſcharge them. And this taſk he accompliſhed, in the civil department, in ſuch a manner, as both added credit to the Court of which he was a member, and was of the moſt eſſential ſervice to the intereſts of law and juſtice. For beſides the learning and experience, acquired by long ſtudy and extenſive practice, he was poſſeſſed of many other more material qualifications, which added much to the power of thoſe attainments, and peculiarly fitted him for the important charge of deciding on the rights of his fellow-citizens.

He was happy in a great natural temperance of diſpoſition and ſoundneſs of judgment. Whence, though he was well able to purſue an intricate and ſubtile argument, and could, on proper occaſions, ſucceſsfully puſh an abſtract principle into all its conſequences, and was ever diſpoſed to beſtow the due ſhare of praiſe on this ſort of acuteneſs in others, yet few were ſo little apt to be dazzled by new or ſplendid notions, or leſs ſubject to the impoſition of falſe refinement. His natural good underſtanding, joined to his knowledge of buſineſs, readily pointed out to him the real ſources and objects of our cuſtoms and ſtatutes, and the conſequences to be dreaded, if theſe were at any time forgotten; and thus, occupying on all occaſions a

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ftrong and fure ground, he was not eafily tempted to abandon it.

To the fame conftitution of mind, he was indebted for his particular eminence in *that* article, wherein perhaps lies the main difficulty of the Judge's tafk,—the difcovering the precife application, or the inapplicability, of the general precepts of law to the particular cafe in hand. He was nowife apt to haften to a fentence, but patiently fufpended his opinion till the due inveftigations had fully ripened the cafe for judgment; which neceffary preparation once made, he then earneftly applied himfelf to underftand, and get poffeffion of, the peculiar circumftances and proper complexion of *that* cafe. Whence it came, that in the courfe of the many years he fat upon the Bench, the number of his judgments as an Ordinary, that were altered on review of the whole Court, was almoft incredibly fmall, and that, in a great proportion of the caufes brought before him, the unfuccefsful party acquiefced in his opinion, and carried the fuit no farther.

HENCE alfo, in the deliberations of the whole Court, it often happened, (as many who now hear me remember), that, by detailing the caufe to the Bench, (which he did with great force and perfpicuity), and fixing upon fpecial circumftances which others had overlooked, or lefs attentively confidered, he was able to turn the tide of argument, and win his brethren over to his opinion.

YET, though this was perhaps his peculiar excellence, he was the very reverfe of a minute or unfteady lawyer. He had, on the contrary, the firmeft hold of the principles and fpirit of the law in every department, and on all occafions that gave fcope for general reafoning, ever drew his opinion, not from the authority of books and precedents, (which hardly any Judge ever dealt lefs in quoting), but from the fource and fountainhead of the law,—the ftrain of our ftatutes, and the reafon and fubftance of the thing.

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BUT in reciting his qualifications as a Judge, we muſt not forget *one*, which was in him amongſt the moſt eminent of any, and on no occaſion forſook or miſled him,—the natural rectitude and pure honour of his own mind,—which, in the numerous claſs of cauſes that depend on the judgment to be formed of the character and conduct of men, directed him with certainty to whatever was faulty in either, and enabled him to ſhow (which he did with much energy and feeling) what the conduct of a truly honeſt man would there have been. Indeed, upon ſuch occaſions, where the intereſt of morality, or the purity of judicial proceedings, was concerned, he was ſometimes led to expatiate at a length which juſt taſte might perhaps have been diſpoſed to blame, had it been a leſs warm and pleaſing proof of his native integrity and cordial attachment to the cauſe of virtue.

WITH all theſe powerful aſſiſtances, which ſo well qualified him to judge with firmneſs and deciſion for himſelf, he poſſeſſed the ſtill more rare, and in a Judge ineſtimable endowment, of the moſt perfect candour, in liſtening to and weighing the ſentiments of others; which virtue was in him ſo conſpicuous, that it might with truth be ſaid of him, that he had no predilection for any opinion, merely becauſe it had once been his own: So ready was he to reconſider his judgment, the moment he ſaw any cauſe to doubt it, and with ſuch perfect openneſs and indifference did he abandon it, however firm his former perſuaſion, upon being (from whatever quarter) convinced of an error.

THESE were his acknowledged merits as a Civil Judge. And his zeal for the public ſervice as Preſident of the Juſticiary, was no leſs conſpicuous and ſucceſsful, as appears from more than one reformation, which the forms and practice of the Court underwent, during the period of his ſitting at the head of it. Of theſe, the moſt remarkable was the fuller eſtabliſhment of the diſtinction in our law between culpable homicide and murder;

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a diftinction which feems to reft upon the ftrongeft grounds in reafon and humanity, and even to be fupported by the language of our books and ftatutes, but which, neverthelefs, the older practice of the Court could fcarcely be faid to have thoroughly recognifed, and which now, in a great meafure, owed its reception into libels and verdicts to the weight of Mr MILLER's opinion, who loft no proper opportunity to countenance and inculcate fo juft a doctrine.

WE may alfo mention among the improvements by him fuggefted, the late ftatutory difpenfation with the tedious, and often unneceffary procefs, of reducing the teftimony of the witneffes into writing.

NOR muft we pafs over his attention to the exterior decorum of this tribunal, fo important to the maintenance of its authority, and which he, in different ways, materially contributed to fupport; having abolifhed certain old, but unfeemly practices, and introduced various becoming obfervances, not before his time required; and, above all, having perfonally added to the refpect and gravity of the Bench, by his rare and happy talent of fuitable, and earneft, and eloquent exhortation to the unfortunate convicts, which impreffed upon the byftanders, and rendered falutary to them, the examples of juftice which his duty conftrained him to make.

Mr MILLER continued, thus honourably to himfelf, and profitably to the public, to difcharge the duties of thefe ftations, without interruption, till the year 1781; at which time, his health being fomewhat impaired by fo long a courfe of conftant application to bufinefs, it was judged advifable for him to difcontinue it, and make a fhort trial of a warmer climate. He accordingly fpent fome months in vifiting different parts of France; and having thence paffed into Italy, he had there the fatisfaction of contemplating the magnificent remains of the grandeur of the people, for whofe language and genius he entertained fo high an admiration, and of furveying

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with his own eyes many of the picturefque fcenes which had fo often delighted him in the defcriptions of their poets. He returned in perfect health, after being abfent for about a year, and refumed his former occupations with his wonted vigour and activity.

IN the month of January 1788, on the death of Prefident DUNDAS, he was, to the entire fatisfaction of his country and the Bar, called to prefide in the Civil Court. His Majefty, at the fame time, thought proper to requite his long fervices, by beftowing on him the title of a Baronet of Great Britain.

IT was a very difficult tafk for any man, the youngeft and moft vigorous, to enter on the extenfive labours of this office, after the Lord Prefident DUNDAS; whofe fingular powers for the rapid difpatch of bufinefs will always be remembered with regret, whoever the perfon be that fills his chair. Yet of his fucceffor, during the fhort time he held it, we may with truth fay, that he gained an acceffion of reputation, by his manner of conducting himfelf in this new ftation, though advanced to the age of *Seventy* before he attained it. And if he fometimes confulted with his brethren upon matters which he might have fettled without fuch deliberation, this was almoft unavoidable upon the firft entry into office; at leaft in a perfon like Sir THOMAS MILLER, who, with the beft pretenfions to lead and direct, was free from all defire to exert his influence. This mildnefs of difpofition fecured to him, in an uncommon degree, the refpect and affection of the Gentlemen at the Bar; whom he always heard with fuch patience, and treated with fuch attention and good breeding, as fhould, more effectually than the fharpeft animadverfion, reprefs all petulance and indecorum.

HAVING thus then gained the fummit of his honeft ambition, in rifing fucceffively, by his own talents and ufeful labours, to all the great offices of the law;—having obtained them all without blame or envy, and held them with credit and diftinction;—happy in retaining, at an advanced age, the full poffeffion

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poffeffion of health and of his faculties, and fortunate in his family and all his domeftic concerns ;—he had little elfe to pray for, (fince Heaven had ordered that he fhould now be called from the fociety of perfons fo dear to him) but an eafy diffolution of his mortal ftate. And this Divine Providence thought fit to grant him.

He died upon the 27th of September 1789, after an illnefs of two days, at his feat of Barfkimming in Ayrfhire, in the 72d year of his age,—leaving no good man his enemy, and attended with that fincere and extenfive regret, which only thofe can hope for, who have occupied the like important ftations, and acquitted themfelves as well.

We have fpoken of him in his public capacity, and noticed his great temperance and folidity of judgment. Now, thefe qualities were in him the more to be praifed, that they did not proceed from any coldnefs or tardinefs of nature, but were, on the contrary, united to a very warm and feeling heart; which was manifeft in his whole life and manners.

No man was perhaps a better citizen, or more genuine patriot, than the late Prefident; if we are to efteem *him* fuch, who not only takes an intereft in the internal welfare and profperity of his country, but feels an honeft pride and warm concern in its glory and confequence as a ftate, and in the fplendour of the peoples fame. Of all thefe, the Prefident had, and continued to have, even in his lateft years, a moft lively fenfe; which was, at one period of his life, the fource of much joy and fatisfaction, and at a later period, of fincere mortification and regret, and caufed him often to lament to the rifing generation, during the misfortunes of the late war, that they had only feen a glimpfe of the glory of their country. That part too of the Britifh dominions which gave him birth, he was attached to with all the partiality which a good man naturally feels; nor was there any fubject on which he dwelt more fre-

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quently, or with more pleafure, than its growing ftate of improvement in his own time.

He was, in like manner, a very focial and hofpitable man; to his family, and connections, and indeed to all about him, full of gentlenefs, and kindnefs, and cordiality: and this uniformly and without exertion; infomuch that no perfon whom he had reafon to efteem or think well of, could ever fay of him, that he received him coldly, or treated him with referve *. Good breeding indeed, (meaning by the term that kind and open manner which fets a ftranger or inferior at eafe) was in a manner natural to him; and he had it to all ranks and conditions of men; fo that in a humane vifit to the houfe of a fervant or dependant, he equally pleafed, and was as furely directed to the very things that were fit and acceptable to be faid, as in his intercourfe with thofe of his own rank. Among whom too, and indeed in all fituations, he was diftinguifhed for a rare fimplicity of manners and opennefs of fpeech; which flowed from a purity of thought and intentions, fo perfect that it was not to be furpaffed.

He retained through life the higheft relifh of the beauties of nature, and every year fpent a confiderable part of the recefs of bufinefs, in the enjoyment and improvement of the roman-

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* Here we muft obferve, that however remarkable this gentlenefs and difpofition to oblige, they were yet always confined to their proper fphere, and in no inftance fuffered to interfere with what he efteemed his duty. This appeared, among other examples that might be given, in his fpirited behaviour as Lord Advocate, on occafion of a queftion that arofe touching the pre-eminence of his office. The late Mr Charles Yorke had been honoured with a patent of precedence over his brethren at the Bar, with exception only of the Attorney-General; and happening to be engaged as Counfel in the Houfe of Lords, on the fame fide with Mr Miller, he, under this privilege, claimed right to be heard before him. Mr Miller, though in habits of intimacy with Mr Yorke, and perfonally very indifferent about any fuch diftinction, felt himfelf here in duty called upon to refift his friend's pretenfions; and accordingly maintained (nor could be prevailed on to recede from it) that he, as his Majefty's Advocate, was Attorney-General for Scotland, and within the exception of the patent. The point was in the end referred to the opinion of Lord Mansfield, which was given in favour of Mr Miller.

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tic fcenes at his place of Barfkimming. It was not, however, to the object of beauty alone, that his attention at thofe feafons was directed, but alfo to the better management and fubftantial melioration of his eftate. And this purfuit engaged him in very numerous and extenfive operations, all of which he himfelf both planned, and fuperintended the execution of, and fuccefsfully conducted ; though in the hands of moft other men, having the fame avocations of bufinefs, without the fame activity, conftancy and love of order, they were more likely to have proved abortive, or even ruinous.

Sir Thomas Miller was twice married. By his firft wife, Margaret Murdoch, daughter of John Murdoch, merchant in Glafgow, he left iffue ; one daughter, and one fon, now Sir William Miller, who follows the fame profeffion in which his father rofe to fuch diftinguifhed honours. His fecond marriage (of which there is no iffue) was to Anne Lockhart, daughter of Mr Lockhart of Caftlehill, who has the misfortune to furvive him. His eldeft brother John had deceafed fome years before him, and he fucceeded, on that event, to the family eftate of Glenlee, which, along with the eftate of Barfkimming, has now devolved to his fon.

END OF THE HISTORY.

de Troms at his place of [illegible]
the object of beauty [illegible] that his attention [illegible]
was directed, but also to the better [illegible]
melioration of [illegible]. And this [illegible]
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conducted; though in the [illegible]
time avocations of [illegible], without the [illegible]
and love of [illegible] they were more likely to [illegible]
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DONATIONS presented to the ROYAL SOCIETY *of Edinburgh, continued from the preceding Volume.*

By *John Macgowan*, Esq; Edinburgh.

Anacardium Occidentale. LIN. The Fruit of the Cashen Tree, preserved in spirits. No. 722.

Castor Fiber. LIN. The Beaver, from Hudson's Bay. No. 723.

Felis Lynx. LIN. The Hudson's Bay Lynx. No. 724.

Canis Lagopus. LIN. The Arctic Fox, from Hudson's Bay. No. 725.

Crotalus Miliarius. LIN. The small Rattlesnake. No. 726.

Coluber Alternus. No. 727.

By the Right Honourable Lord *Daer*.

A number of articles, collected in the South Seas by Captain BLIGH.

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A Musical Instrument made of Reeds. No. 729.

An Arrow-head, formed of a hard black Schistus. No. 730.

Fish-hooks of Mother of Pearl, and Lines, from the Friendly Islands. No. 731.—733.

Fish-hooks, and Lines, formed of the Sinews of an Animal from the coast of America, in Lat. 49° N. No. 734.—736.

Capnias Australis, Smectis Australis, Catochites Australis, } from the South Sea Islands. No. 737.—739.

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List of Donations.

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Six Arrows from Bengal. No. 743.

A Malay Poinard. No. 744.

Lapis Judaicus, from the Eaſt Indies. No. 745.

By *John Learmonth*, Eſq; Merchant in Edinburgh.

Scolopendra Gigantea, LIN. above fourteen inches long, from the Weſt Indies, preſerved in ſpirits. No. 746.

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A Sceptre of Ivory, mounted with ſilver, given by the King of Dachomy, in Africa, to *Archibald Dalzel*, Eſq; formerly Governor of Whydah, as a teſtimony of friendſhip. No. 747.

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Some large Nodules of Flint, from Italy; each having cryſtalliſations in a large central cavity, ſent from Leghorn by Sir *John Dick*. No. 749.

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A white Greenland Bear. No. 750.

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Colymbus Arcticus, LIN. ſhot on the ſhore of Eaſt Lothian. No. 751.

By the Honourable Lord *Hailes*.

Trichechus Roſmarus. LIN. The Morſe or Sea Horſe; the Skeleton of the Head entire, with the Tuſks. No. 752.

By

Lift of Donations.

By Mr *John Macaulay*, Town-clerk of Dumbarton.

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An Indian Canoe, of fine workmanfhip, from the Ifland of St John. No. 754.

By Dr *Gregory*.

A large Lizard, from the Weft Indies, preferved in fpirits. No. 755.

By *William Henry Charters*, Efq; of Burntifland.

Lava Garnets, found in the Lava, which overwhelmed Pompeii. No. 756.

Two Copper Coins. No. 757. 758.

A Silver Coin of *Henry* VI. ftruck at Calais, and found in the river Jed. No. 759.

By Dr *Roxburgh* at Madrafs.

A Cheft of Plants from Bengal and the Peninfula of India, containing feveral hundred Plants, in fine condition, and arranged according to the Linnean fyftem.

By *The American Academy of Arts and Sciences*.

Memoirs of the American Academy of Arts and Sciences, to the end of the year 1783, Vol. I. 4to. Bofton, 1785.

By *The Royal Irifh Academy*.

The Tranfactions of the Royal Irifh Academy. 4to. Dublin, 1787.

By

Lift of Donations.

By *Adair Crawford*, M. D.

Experiments and Obfervations on Animal Heat, and the Inflammation of Combuftible Bodies, *&c.* The fecond edition. 8vo. London, 1788.

By Dr *Carlyle.*

The Hufbandry of the Ancients, by *Adam Dickfon*, A. M. late Minifter of Whittingham. 2 Vols. 8vo. Edinburgh, 1788.

By *E. Peart*, M. D.

The Generation of Animal Heat inveftigated, &c. 8vo. Gainfborough, 1788.

By *M. Lavoifier.*

Traité Elémentaire de Chimie. 2 Vol. 8vo. à Paris, 1789.

By *Thomas Percival*, M. D.

Effays Medical, Philofophical and Experimental, Vol. II. 8vo. 4th edition, revifed and enlarged. Warrington, 1789.

By the Reverend *Archibald Alifon*, A. B.

Effays on the Nature and Principles of Tafte. 4to. Edinburgh, 1790.

TRANS-

TRANSACTIONS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. PART II.

PAPERS READ BEFORE THE SOCIETY.

I.

PAPERS OF THE PHYSICAL CLASS.

I. *Of certain* NATURAL APPEARANCES *of the Ground on the Hill of Arthur's Seat.* *By JAMES HUTTON,* M. D. F. R. S. EDIN. *and Member of the Royal Academy of Agriculture at* PARIS *.

IN ſummer 1776, Profeſſor FERGUSON obſerved a particular appearance on the hill of Arthur's Seat, near the ſummit, which drew his attention, and which he could not underſtand. He then carried Dr BLACK and me to the place, where we found ſomething which, at a diſtance, reſembled the withered graſs of a foot-path, but which traverſed a ſhoulder of the hill, in ſuch a direction as correſponded to neither ſheep-track nor foot-path. Upon a near inſpection, it appeared to be a narrow ſtripe of the graſs quite dead and withered. The breadth of this ſtripe was about nine, or, in ſome places, twelve inches; the ſides of this track were perfectly defined, without any gradation from green to withered graſs, all the plants in the track being killed, without the contiguous part having ſuffered in the leaſt. The length of this track was conſiderable, a hundred yards or two, extending from the ſouth-eaſt ſide of

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* This Paper was read before the Philoſophical Society of Edinburgh in June 1778. It is now printed by order of the Committee for publication of the Tranſactions of the Royal Society of Edinburgh.

the ſouthmoſt hill through a hollow, and aſcending obliquely the ſhoulder of the ſummit of Arthur's Seat on the ſouth-eaſt ſide.

At firſt thunder ſuggeſted itſelf as having been the cauſe of this remarkable appearance; but the more we enquired into the particulars of this phenomenon, the greater difficulties occurred with regard to the proper correſpondence of that conjectured cauſe, as well as for aſſigning any other with the leaſt degree of probability. It is with a view to make this appear, that the following hiſtory is made of the particulars which were at that time, and have been ſince obſerved.

Observation 1. The appearance now deſcribed was not the only one of the kind; for, upon examination, I found ſimilar tracks, though of various extent, in all the different aſpects and ſituations, from the ſouth ſide of the ſummit to the north ſide of the hill half way down to the plain; but none at the bottom.

Obs. 2. These appearances, though recent, or of that year's production, had not been the firſt thing of that kind which had appeared on the hill; for, parallel to each of thoſe tracks of withered graſs, there was another perfectly ſimilar, which then appeared to us as if it had been made the year before, and was then black, the graſs having rotted. The diſtance of this old track from the new, was, in general, only a few inches, ſometimes exceeding near, but rarely or never contiguous.

Obs. 3. The tracks, now under conſideration, have been conſidered as a thing continuous in its length; but this it is only in general, or in certain portions where it is ſo ſometimes for a conſiderable extent. In other places, again, it is compoſed of ſeveral portions of various lengths, the graſs being unaffected betwixt thoſe portions which make up the track; ſo that, in ſome places, the track is made as it were by ſpots; and theſe ſpots, although in general longer in the direction of the track, are not always ſo, there being in ſome places, generally at the extremity

extremity of the track, ſpots whoſe length do not exceed their breadth. *

OBS. 4. THE regularity with which thoſe two tracks run parallel and near to each other, is not more wonderful than is the correſpondency that is in general to be obſerved with regard to the conſtruction of theſe, as conſiſting either of a continuous track or of ſeparate pieces; and to ſo great a degree is carried this reſemblance of the two tracks, that, where it is by ſpots the tracks are made, there the ſimilarity, even of the ſpots, were ſometimes remarked, ſo that it ſeemed as if the one had been a copy of the other.

OBS. 5. BESIDES the brown colour of thoſe new made tracks, which might be ſeen at a conſiderable diſtance, (two or three hundred feet), there was another ſtripe of a dark green, which might be ſeen at a ſtill greater diſtance. Upon more cloſe examination, this laſt appearance was found to take its origin in ſome graſs of a very dark green, which, in ſome places here and there of the laſt year's track, began to grow in the black ground and among the rotten graſs; but the greateſt part of this deep green was behind the laſt year's track, and was evidently owing to a ſimilar growth of graſſes in places which had been formerly killed or withered, and were now almoſt covered with new plants, which gave a deeper ſhade of green than the reſt of the hill.

THIS laſt obſervation led to another; for here a queſtion naturally occurred, That, ſince this ſucceſſion of things had certainly taken place at leaſt three years, how many ſucceſſive tracks might be detected from the examination of thoſe appearances? With this view I conſidered attentively ſome places where the marks were moſt diſtinct, and could plainly count five or ſix ſucceſſions; the number cannot be accurately aſcertained, becauſe thoſe which have been made above three or four years are much effaced, although the colour, and ſome other marks, evidently prove, that there had been ſeveral more.

OBS.

Obs. 6. The tracks which have been now deſcribed, are not ſtraight lines, but have all more or leſs of a regular circular nature in them; that is to ſay, they are ſegments of circular figures, and only approach to the appearance of right lines, in proportion as the figure of which they are the ſegments is large, or the ſegment ſmall; and in thoſe reſpects there appears to be great variety. There is, however, one appearance which, at firſt ſight, might impoſe upon an obſervator, and deſtroy the generality of this obſervation. It is an inſtance or two that occur of a continued line in thoſe tracks; but, in this caſe, the line appears to be made up of ſeveral ſegments, each of which ought to be conſidered by itſelf; conſequently, here will be acknowledged the operation of the ſame general principle by which, in thoſe appearances, a regular figure is produced, and that this figure is in its nature circular.

Obs. 7. The production of thoſe tracks being ſucceſſive in its nature, or operating in different places at different periods of time, ſuggeſts another ſubject of enquiry, *viz.* How far any regularity, or a certain order, may be obſerved alſo with regard to this operation, as well as with regard to that by which the figure is produced? And this, from obſervation, I think, is determined in the affirmative, ſo far as, from all the obſervations I have made, this progreſs ſeems always to have proceeded in the direction of a line, drawn from the centre, biſecting the ſegment; that is to ſay, thoſe portions of concentric circles are never inſcribed, but always circumſcribed; and, for this reaſon, it will appear, that thoſe circles, of which ſegments are exhibited to our obſervation, muſt be increaſing, and not diminiſhing, in their diameter.

Having thus given an account of what was concluded from the firſt ſeaſon of thoſe obſervations, before proceeding to give the continuation of their hiſtory, it may be proper to obſerve, that an unſucceſsful attempt was once made to inveſtigate the

cauſe,

cauſe, by the inſpection of the turf cut up, and compared with that immediately contiguous to the track; for, on that occaſion, nothing was found that could give any light into the nature of the operation.

FROM the narration of appearances already made, the hiſtory of what has happened ſince that ſummer, 1776, will be extremely ſhort, and may be comprehended in two or three words.

IN the ſummer 1776, there was prognoſticated a ſucceſſion of appearances ſimilar to thoſe which, from the obſervations then made, had been concluded as having already come to paſs, and been tranſacted with a certain regularity in a former period of time. The event has fully juſtified the judgment which was formed at that time, reſpecting the order and regularity of the appearances, and has alſo left us in the ſame ſtate of uncertainty, or rather ignorance, with regard to the cauſe.

IN the ſpring, about the month of April, the graſs begins gradually to wither and decay. It is perfectly dead in a little time, that is, in a week or two, and then appears white or withered. Thus, every plant being killed in the new track, thoſe vegetable bodies, expoſed to heat and moiſture, gradually decay, ſo as next year to exhibit a dark or black, inſtead of a light or white track, which it had been the year before; but during the ſecond year, the dead plants are ſtill obſerved in the turf, which, as it begins to get new plants, loſes gradually the appearance of the old ones, until at laſt little more can be obſerved, than a broad ſhade of a much deeper green, which, on the one ſide, is compared with the natural verdure into which it ſometimes ſeems gradually to terminate; whereas, on the other ſide, the deep green colour of the ground formerly tracked, is contraſted with the yellow or light colour of the withered graſs.

FROM the inſpection of the ground, and the hiſtory of what has been obſerved to happen, nothing is more evident than that this regular ſucceſſive operation has been now repeated, at leaſt

in

in ſome parts of the hill, for eight or nine years. Here, therefore, is a piece of natural hiſtory worth recording, and for which a theory is wanted.

THE appearances which have been deſcribed are, ſo far as I know, ſingular and unconnected with all others reſulting from known cauſes. I know that ſimilar circles have been obſerved by naturaliſts, and by them aſcribed to thunder; as we ſhould certainly have done in this caſe, were it not for the regular annual progreſſion, which, if the effect of thunder, muſt follow rules not yet inveſtigated, either in electricity, vegetation or the mineral ſyſtem; for,

How comes it, that the electrical operation takes place regularly in the ſpring only, and that without any appearance of thunder?

2dly, How comes it, that the ſtripe of graſs deſtroyed by one operation, is always regularly progreſſive in one particular direction, in relation to the firſt electrical operation?

3dly, IF this progreſſive appearance ſhall be conſidered as an electrical operation, and every ſucceſſive repetition as directed by the one immediately preceding it; then, how was the firſt produced; when was it; and when will be the laſt?

THE next conjectural cauſe that ſuggeſts itſelf as an explanation of thoſe appearances, is the operation of inſects. But there ſeems to be no leſs difficulty in reconciling any known animal-œconomy with the appearances under conſideration, as the only cauſe of thoſe appearances; for,

How ſhould thoſe animals have been diſtributed in thoſe ſeparated tribes upon the hill, and diſpoſed in the continuous tracks, ſo as to exhibit lines of long extent, traverſing ground and ſoil of various quality, as well as in tracks of very little extent; but, whether great or ſmall, formed upon the ſame principle, every part having a ſimilar relation to a whole?

ARE theſe large tracks to be conſidered as the extenſion of colonies which once had been ſmall? or, Are theſe colonies

dropped

dropped from the atmoſphere upon the different parts of the hill, in the ſhape and extent in which we find thoſe ſtripes of withered graſs? This laſt hypotheſis is not ſupported by any appearance that I know of in this country; and the other is not conſiſtent with the natural appearances to which it muſt belong; for the ſolitary or inſulated ſpots, which often form part of a ſtripe, ſeem to be reproduced, in nearly equal quantity, each ſucceeding year, without any gradual extenſion in the ſtripe, which alſo ſeems to preſerve its former extent, as well as breadth and form.

THEREFORE, when we conſider the various ſituations and extent of thoſe narrow ſtripes of withered graſs, the regularity to be obſerved in their ſhape and progreſſion, and the conſtancy which ſeems to take place with regard to their ſucceſſion, we muſt, at the ſame time, be perſuaded, that there is a natural cauſe which may be inveſtigated for the explanation of thoſe appearances, and reject the mere ſuppoſition of cauſes which do not ſeem, of themſelves, adequate to the effect perceived.

GREAT attention would be required in making obſervations with a view to diſcover the cauſe of thoſe appearances; and the difficulty of this taſk is much increaſed by an ambiguity which occurs on certain occaſions, where the breeding of inſects in conſequence of the death of plants, may be miſtaken for the death of plants in conſequence of inſects; but, on the other hand, in the preſent caſe, great advantage, for an enquiry of this ſort, may be derived from the opportunity that there is of examining, not only what had been killed the preceding, but alſo that part which is, perhaps, to be killed the enſuing ſeaſon; and where experiment may be made by cutting off the communication betwixt thoſe two parts as deep as the ſoil may admit.

THE apparent production, or rather the multiplication of ſome ſpecies of animals, in conſequence of a certain deſtruction

of the vegetable turf, is a thing eaſily to be conceived, like what happens in thoſe ſtripes the ſecond year, when I have ſeen an abundant crop of a certain ſpecies of muſhrooms in the track. Had animals of a particular ſpecies been found there, in the examination of the ſoil in thoſe withered tracks, a raſh concluſion might have been formed, in erroneouſly attributing as a cauſe for the appearance, what was truly an effect or conſequence of the thing in queſtion.

It is always making a ſtep towards the diſcovering the cauſe of a phenomenon, when cauſes which, with ſome degree of probability, have been aſcribed to an event, are found to be unconnected with, or to have no affinity to it; for this is the natural method of inveſtigation, by examining the affinities or relations of things, and rejecting thoſe as properly related, where there is found a diſcrepancy. Thus, as there is no effect without its proper cauſe; ſo, in proportion as a greater number of events are found to be unconnected with an appearance, ſome kind of approach is made towards that by which the natural appearance is to be explained; but in caſes where events are multiplied or numberleſs, every approach of this kind is only negative; and ſuch a method of inveſtigation, while it may be the means of diſcovering the thing in queſtion, only ſhows that what we want is not attained. This, however, if made with full conviction, is no contemptible ſtep in natural philoſophy, where, next to the inveſtigation of the proper order in events, it is of the higheſt importance to avoid, or to correct, the improper connection of them.

The explanation of the phenomena, in the preſent piece of natural hiſtory, either by thunder or the operation of inſects, without having obſerved the actual connection of thoſe different events, is merely conjectural, as would be equally the refuſing to admit for explanation a known cauſe, which, though not actually obſerved as connected with the event in queſtion, had,

had, in other respects, the requisites for producing a similar effect.

But all that is known at present of electricity, or the operation of insects, is far from being sufficient to be considered as the explanation of the appearances in question; for,

Though the growing plants, or the vegetation of a portion of the living turf, may be killed either by means of electricity or insects, these are not the only means by which that effect may be brought about; at the same time that this is the only circumstance, in the natural appearance, explainable by the supposed cause: Therefore, as every circumstance in an appearance must be properly related to a cause, by which it is to be explained, so the many circumstances here found, without any affinity to, if not inconsistent with the conjectured cause, will leave no room for admitting such an explanation, according to the present view which has been given of the subject.

II. *An* Account *of the Method of making the* OTTER *of* ROSES, *as it is prepared in the East Indies. Communicated in a Letter from* Donald Monro, M. D. *of London, to Mr* John Robison, *Professor of Natural Philosophy in the University of* Edinburgh *.

SIR, *London, Jermyn Street, July* 10. 1783.

I Had the following receipt for making the *Otter of Roses*, as it is prepared in the East Indies, from Major Mackenzie of Coull, in the county of Ross, who told me he got the account from an officer of his corps, who was up in the country where it is prepared, and assisted in making it himself.

Take a very large glazed earthen or stone jar, or a large clean wooden cask; fill it with the leaves of the flowers of roses, very well picked, and freed from all seeds and stalks; pour on them as much pure spring water as will cover them, and set the vessel in the sun in the morning at sunrise, and let it stand till the evening, when take it into the house for the night; expose it in this manner for six or seven successive days, and, at the end of the third or fourth day, a number of particles, of a fine yellow oily matter, will float on the surface, which, in two or three days more, will gather into a scum, which is the Otter of Roses. This is taken up by some cotton, tied to the end of a piece of stick, and squeezed with the finger and thumb into a small phial, which is immediately well stopped; and this is repeated

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repeated for ſome ſucceſſive evenings, or while any of this fine eſſential oil riſes to the ſurface of the water.

N. B. I HAVE been informed that ſome few drops of this eſſential oil have been more than once collected by diſtillation, in the ſame manner as the eſſential oils of other plants here in London. I am,

SIR,

Your moſt obedient humble ſervant,

D. MONRO.

III.

III. DESCRIPTION *of a* MERCURIAL LEVEL, *invented by* *ALEXANDER* *KEITH*, *Esq;* F.R.S. & A.S. EDIN.*.

FIGURE I. is a ſection of the inſtrument formed of mahogany or boxwood. A A are two oblong ſquare cavities connected together by a narrow cloſe channel, running from the bottom of the one to the other. B B are two grooves hollowed out of the wood, in order to contain the ſights, *&c.* They are ſhut up by a lid, which turns upon a ſcrew-nail at the centre C, as may be ſeen more diſtinctly from fig. 4.

FIG. 2. D D are the two ſights, the one with a ſmall hole, the other with a croſs-hair. Theſe ſights are erected upon two pieces of ivory or hard wood, which are ſhaped nearly of the dimenſions of the cavities A A, but ſo much ſmaller as to enter without touching or rubbing on the ſides. Mercury is poured into the two holes A A till they are about half full; the two pieces of ivory which ſupport the ſights, are put into the cavities, and float on the ſurface of the mercury.

FIG. 3. is a perſpective view of the inſtrument when the ſights are floating upon the mercury; and fig. 4. is another view of it, when the ſights are taken out and the lid is open.

As the two cavities communicate with each other, the ſurface of mercury in both are always upon the ſame line of level; and conſequently, if the two ſights are once accurately adjuſted, they will ever after point out the true level, without requiring any after adjuſtment.

WHEN this inſtrument is to be uſed, it may be laid on any horizontal ſurface, and the ſights will immediately become an exact

* This Paper was read before the Philoſophical Society of Edinburgh in December 1778; and is now printed by order of the Committee for publication of the Tranſactions of the Royal Society of Edinburgh.

exact level. It may also be fixed on a tripod as the spirit-level; or it will answer equally well, if it is affixed to the top of a single stake, which is sharpened at the point so as to be pushed into the ground. If it is to be used as a pocket-instrument, it may be made of seven inches length, being about double the dimensions of the annexed draught. A common walking cane forms a very convenient support. It is affixed to the cane by means of a brass pin E, which passes through the hole G, and through the eye or hole of the walking stick; and a brass nut F, screwing to the male-screw of the brass pin, keeps them firm together. The two grooves B B, contain the two sights and brass pin, when not in use. Two corks, covered with thin leather, fitted into the holes A A, confine the mercury, when the instrument is to be transported; or, in case the mercury is found to escape, it may be poured into a small case, made of lignum vitæ, like a tooth-pick case; and this may be stopped with a cork, and made to fit into one of the grooves.

The advantages of this instrument over the spirit-level are: *1st*, It requires no adjustment, consequently two observers, though otherwise not equally accurate, must make the same observation. *2dly*, With this, the level of twenty different places may be taken during the time required to adjust the spirit-level for one observation. *3dly*, The nicety of the spirit-level depends upon the small curve of the glass-tube, in the choice of which no rule can be laid down; neither is any thing gained, in point of exactness, by lengthening the spirit-tube above three or four inches. But every instrument of this kind is of one standard; and the further the two sights are removed from one another, the more any error is diminished. *4thly*, This instrument can be made perfectly just, without taking any observation, or comparing it with another level. In order to do this, let the floats on which the sights rest, be of the same dimension and weight, and let the cross-hair and eye-hole be of one height, and, without farther adjustment, they will point out the true level.

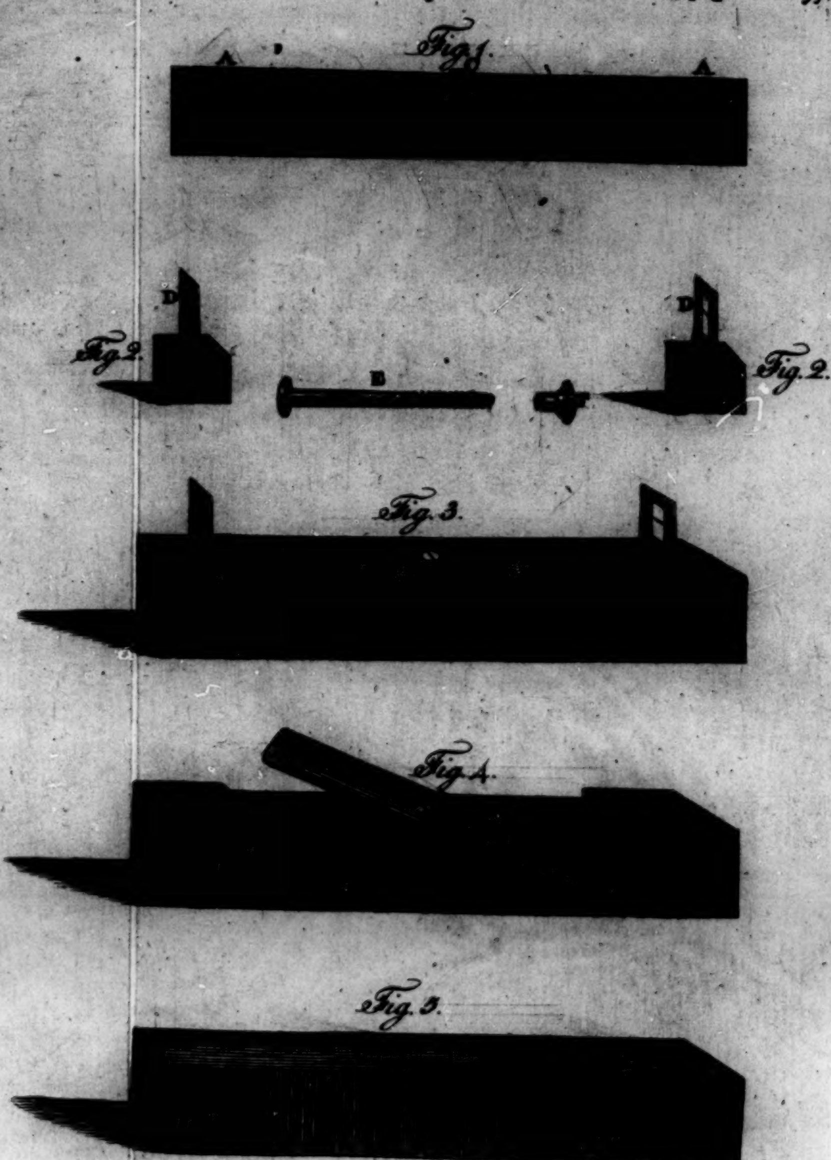
THE

The following is a proof of the exactneſs of this method. John Miller, the mathematical inſtrument-maker, has a line drawn upon the oppoſite ſide of the Parliament-ſquare, fronting his ſhop, by which he has been in uſe to adjuſt his ſpirit-levels. We placed the mercurial level upon the ſpot known to be upon an exact level with the line. Both he and I looked through the ſights; but could not perceive the line. We ſuſpected there was ſome fault in the ſights; but, on making them vibrate, we found that the hair had covered the line; ſo ſoon as they ſettled, the line was again covered by the hair.

When there is a ſtrong wind, the ſights vibrate too much. In order to remedy this, there is a caſe of tin'd plate or paſteboard made to incloſe the inſtrument when not in uſe. *Vid.* fig. 5. When uſed, the caſe covers only about one half of it, leaving room for the ſights to float within the caſe. There are two oval holes at each end of the caſe through which the obſervations are made.

IV.

[To fold out, facing page 16. Phys. Cl.]



I. Beugo Sculp.

IV. PATHOLOGICAL OBSERVATIONS *on the* BRAIN. *By Mr THOMAS ANDERSON*, F.R.S. EDIN. *Surgeon at Leith, and Fellow of the Royal College of Surgeons* *.

THE following obſervations may ſerve to illuſtrate and confirm the opinion now very generally adopted by Anatomiſts and Phyſicians, That an affection of one hemiſphere of the brain, whether from internal diſeaſe or external accident, produces its morbid ſymptoms on the oppoſite ſide of the body.

CASE I. A LADY about forty, whom I attended along with Dr MONRO, was for many years affected with violent headachs; ſhe complained of the pain being moſt violent in the crown of her head, which at laſt brought on convulſive tremors of the left arm and leg; theſe often continued half an hour, and would return three or four times a-day; the fits grew more ſevere and frequent, and the right ſide became affected, and frequently ſhe was comatoſe for twenty-four hours, till, quite worn out, ſhe died in November 1770.

ON opening her head, when the dura mater was taken off, on the right hemiſphere of the brain, there was a loſs of ſubſtance, for about two inches and a half in length, one and a half in breadth, and about the middle near an inch deep, the length of which was in the direction of the falx: In the middle of this, immediately under the coronal ſuture, and on the ſide neareſt to the falx, within an inch of it, there was ſome ſoft

* Read before the Philoſophical Society of Edinburgh in 1781; and now printed by order of the Committee for publication of the Tranſactions of the Royal Society of Edinburgh.

browniſh matter in the bottom, on touching of which with the knife, I diſcovered ſtony concretions, which were taken out and waſhed. Several of them broke into ſand on the ſlighteſt touch; but four or five of them, each about the ſixth of an inch in length and breadth, and a little thicker than the ſhell of an egg, I ſaved, and afterwards gave to Dr Monro, who was not then preſent.

Case 2. William C. about forty-five, of a corpulent habit, was, for ſeveral years, ſubject to epileptic fits, which commonly returned every three or four weeks, and any irregularity in eating or drinking would immediately bring them on; but when cautious, living ſparingly, and taking ſome laxative, he was often free from them for four or five months.

The fits always came on with convulſive motions in the right arm and leg, which, in a few minutes, were ſucceeded by ſtupor, in which he continued above half an hour. In November 1775, he received a ſtroke on his head, which brought him to the ground; was inſtantly ſeized with one of the fits; and, in twenty-four hours, had ten or twelve of them, in all of which the only parts convulſed were the right arm and leg; the fits became more frequent, a total ſtupor came on, and he died fourteen days after.

On opening his head, on the left hemiſphere, immediately under the coronal ſuture, and an inch from the falx, the dura mater adhered to the brain, for about the ſize of a ſhilling, and was ſo much thickened and hardened as to be in a cartilaginous ſtate; the brain, for the ſize of a large walnut, was much hardened, and the under part of it adhered ſlightly to the falx; on the outer ſide of this hardneſs, on that ſide furtheſt from the falx, and in the middle of the ſubſtance of the cerebrum, there was about an ounce and a half of extravaſated blood, which was ſoft, and of a black colour.

Case

CASE 3. ROBERT H. a ſailor, about forty, when on board of ſhip, ſtooping down, received a violent ſtroke on the back part of the parietal bones by the falling of a boom; there was no wound, but the parts were much bruiſed. Some months after, he complained of a pain immediately under the part on which he received the ſtroke, which gradually grew worſe, and in a year and half the pain was moſt excruciating, and brought on violent convulſions in both upper and lower extremities of both ſides, the violence of which, in ſome months, put an end to his life.

ON opening the head, the poſterior part of both hemiſpheres of the brain was found greatly inflamed and much hardened; and adhered firmly to the dura mater and the falx; the left ſide was more diſeaſed than the right, and the dura mater, in ſome places where it adhered firmly, was much thickened, and almoſt cartilaginous.

CASE 4. Mr L. by a fall down a ſtair, fractured the left parietal bone. I ſaw him in half an hour, when he was in a ſtupor. He was immediately bled very plentifully, and then carried home. The fracture extended from the middle of the bone downwards and backwards, and was traced near to the maſtoid proceſs; but I could not carry the inciſion any further. A piece of the bone was taken out by the trepan; a conſiderable quantity of extravaſated ſerum and blood was found preſſing on the dura mater, which was got out; the wound was dreſſed, and he was bled very plentifully a ſecond time; after which he became ſenſible, and anſwered diſtinctly when ſpoken to, and, after ſleeping ſome hours, was greatly relieved, but at times the right leg and arm were attacked with convulſive tremors, which continued for three days, and, on the fourth day, every ſymptom appeared very favourable, and he had the appearance of doing well; but he frequently complained of a pain in his head. On the twentieth day, he was ſeized

with rigor, which was ſucceeded by a feveriſh paroxyſm, that frequently returned for three days; his pulſe became conſtantly quick, and he died the twenty-eighth day. His friends would not conſent to his head being opened.

CASE 5. ALEXANDER H. a lad of eighteen, fell into the hold of a ſhip about fifteen feet down, and was carried home in a ſtupor. A tumefaction was obſerved on the top of the right parietal bone. After a plentiful bleeding, he recovered of the ſtupor; a laxative was given, and he was bled again in the evening. On the third day, the ſtupor returned; and, on the evening of that day, I was called in, when there was every ſymptom of compreſſion of the brain, and next morning Dr MONRO and Dr AUSTIN were ſent for. It was then judged proper to examine the ſtate of the right parietal bone, where the tumefaction was at firſt obſerved. No fracture could be found; but a piece of the bone was taken out by the trepan. Nothing was ſeen that could occaſion any preſſure. The ſtupor, *&c.* continued, and he died the thirteenth day. Eighteen hours after his death, I went to open his head; but ſuch a degree of putrefaction was come on, that a great part of the brain had come out of the hole in the bone, quite diſſolved and putrid. The teguments were taken off, but no fracture was found in any part of the head.

CASE 6. A ſailor boy of fourteen fell into the hold of a ſhip. He was carried aſhore in a ſtupor. There was a ſwelling on the middle of the right parietal bone, without any wound. He was bled, and put to bed; and, in half an hour, was ſo much recovered, that it was thought unneceſſary to inſpect the ſtate of the bone. He was ordered a laxative to take in the night; but next morning it had not operated. It was then repeated; and in the evening he appeared very well; but there ſeemed to be a degree of torpor in the inteſtinal canal, from the laxatives

laxatives not operating. A clyſter was given, and the laxative again repeated. Next morning, his left arm and leg were quite paralytic, the pupil of the left eye was dilated, and did not contract when a lighted candle was brought near it, nor was he ſenſible of its being there; but he could read diſtinctly with the other eye, and the right leg and arm were very well. In the afternoon, juſt forty-eight hours from the time that he met with the accident, the bone was laid bare, and in the middle of the right parietal bone, a piece was found to be broken off more than an inch ſquare. The upper ſide had pierced the dura mater, and gone into the ſubſtance of the cerebrum. The broken piece was eaſily taken out, and the wound dreſſed. Immediately after, the pupil of the left eye contracted, and he could diſtinguiſh large objects with that eye, and the leg and arm were leſs affected. He had a good night, and next morning could read when the right eye was ſhut. On the third day after the operation, when the wound in the dura mater inflamed, and a conſiderable tumefaction came on, his left eye, leg and arm became again paralytic, with frequent convulſions in the left leg and arm, but without the ſmalleſt complaint in the other ſide. In this ſtate, he continued for ſeveral days; a ſuppuration came on; the ſwelling went off; after which he continued well, and the wound healed up in eight weeks.

FROM theſe caſes, I ſhould infer:

1. THAT when one hemiſphere of the brain is affected, it generally produces its morbid ſymptoms on the oppoſite ſide of the body.

2. THAT when both hemiſpheres are affected, the whole body ſuffers.

3. THAT though one hemiſphere only is affected, when the injury is great, the whole body will ſuffer.

4. THAT

4. THAT though the cerebrum alone is hurt, it produces morbid ſymptoms in all muſcles of voluntary motion, whether their nerves take their riſe immediately from the cerebrum, from the cerebellum, or from the medulla oblongata.

5. THAT, in caſes of external accident, where one ſide is affected, it is more favourable than when both ſides ſuffer.

V.

V. EXPERIMENTS *on the* EXPANSIVE FORCE *of* FREEZING WATER, *made by Major* EDWARD WILLIAMS *of the Royal Artillery, at Quebec in Canada, in the years* 1784 *and* 1785. *Communicated in a Letter from* CHARLES HUTTON, LL. D. F. R. SS. LOND. & EDIN. *and Professor of Mathematics in the Royal Military Academy of Woolwich, to Professor* JOHN ROBISON, *General Secretary of the Royal Society of Edinburgh.*

[*Read by Mr* ROBISON, *Nov.* 6. 1786.]

SIR,

THE following is an extract of a letter to me from Major EDWARD WILLIAMS, of the Royal Artillery, a learned man, and of great professional merit. Being at Quebec in some very cold winters, among various other ingenious experiments, it occurred to him to try the force of congelation in some of the iron bomb-shells, which are usually fired out of mortars in the practice of artillery; by filling the cavity of the shell with water, and then, having plugged up the fuze-hole, exposing it to the cold to freeze the water, in order to find whether the expansion of the ice would be capable of bursting the shell.

THE dimensions of the 13 inch shell are as follow:

		Inches.
Outer diameter of the shell,	-	12.8
Inner, or diameter of the cavity,	-	9.1
Thickness of metal at the fuze-hole,		1.5
Ditto at the bottom or opposite part,		2.2
Diameter of the fuze-hole,	-	1.7

And the dimensions are similar in the other shells. The fuze-hole is conical, the opposite sides of which, when produced, meet

meet at the extremity of the diameter, which paſſes through the middle of the hole.

He found, that the iron plug could hardly ever be driven ſo firmly into the fuze-hole as to reſiſt the force of the expanſion of the ice, which puſhed it out with great velocity, and a bolt or cylinder of ice, of a conſiderable length, immediately ſhot up from the hole. But when the plug was fixed in with ſprings, which laid hold of the inſide of the cavity, ſo that the plug could not poſſibly be puſhed out, the force of expanſion then ſplit the ſhell, and a fin or plate of ice ſhot out quite around.

EXTRACT *from Major* William's *Letter*.

These experiments were made on iron-ſhells, from the 13 inch-ſhell to the coehorn, of 4.4 inches diameter, by filling the ſhell nearly with water, and driving in an iron plug with a ſledge hammer.

Time. 1784.	Hour.	Barom.	Ther.	Wind.	Elev. of the fuze	Wt of plug. oz	Diſtance.
Dec. 21.	12 night.	29.66	— 10	Weſterly.	90	35	Unknown.
22.	10 A. M.	29.69	— 3	Eaſterly.	90	37.25	22 feet.
23.	9 P. M.	29.80	— 16	W.	90	34.5	Unknown.
24.	11 A. M.	29.25	— 6	W.	80	39.25	62
31.	11 A. M.	29.60	— 18	W.	45	39.25	387
1785.							
Jan. 2.	5 A. M.	29.96	— 19	W.	45	41.75	415
4.	7 A. M.	29.46	— 12	W.	45	42	Burſt.
9.	9 A. M.	29.35	— 4	W.	45	40.5	325

REMARKS.

Dec. 21.—The fuze-axis of the ſhell lay nearly perpendicular to the horizon. On examining the effect, about 9 o'clock the following day, I obſerved the plug gone, and a cylinder of ice, of 4½ inches high, riſing perpendicularly from the fuze-hole, and of equal diameter. I ſearched carefully for the plug, but

but could not find it, as there was about 3½ feet of ſnow on the ground.

22.—I WATCHED this ſhell about an hour, when, being called out on buſineſs, I found, on my return, three hours after, the plug gone, and the icy cylinder 2¼ inches high. Plug loſt.

23.—I HAD a plug made, and jagged or notched along the ſides, to prevent its being forced out ſo eaſily; and watched this ſhell for upwards of three hours, going into the houſe at intervals to warm myſelf. The laſt time I went in was about half an hour after twelve, when, after a few minutes, I heard a ſort of hiſſing ſound, upon which running out, the plug was gone, and a cylinder of ice ſhot up, exceeding any of the former, being 6½ inches high. Plug loſt.

24.—A SIMILAR plug to the laſt. I watched this with more ſucceſs; for although abſent at intervals; yet at half paſt four in the afternoon, (therm. at 6°) I ſaw the plug ſuddenly forced out by the column of ice, accompanied by the hiſſing noiſe; and, obſerving its fall, I found it at 62 feet from the ſhell. The icy cylinder was 4 inches high, and the fuze-axis of the ſhell I found lay nearly at an angle of 80° with the horizon.

31.—CONCLUDING from the foregoing experiments, that no plug could be ſo fixed, as to render the reſiſtance at the fuze-hole greater than at the weakeſt part of the ſhell, in which caſe I ſuppoſed it would burſt, (which was the primary object in theſe experiments) I thought it might be worth while to obſerve how far the force of congelation would project a plug of a given weight and figure, and forced in with the ſame number of ſtrokes of the ſledge hammer. For this purpoſe, I placed the fuze-axis of the ſhell at an angle of 45° with the horizon, and on the 31ſt of December 1784, being the coldeſt day of this year, the plug was projected whilſt I was abſent, a cylinder was ſhot out, in the direction of the axis, of 7½ inches, and not in-

clining in the leaſt from that direction to the horizon. The plug was loſt.

Jan. 2. 1785.—Being colder than 31ſt December, in order to haſten the effect, I put a mixture of common ſalt and ſal ammoniac to the water, and tied a long pack-thread, with a piece of red rag at its end, to the fuze, in order to find where it fell in the ſnow. This plug made its eſcape, like the reſt; for at half paſt ſix it was flown, and a cylinder of $8\frac{1}{2}$ inches of ice ſtanding over the fuze-hole. The plug was loſt; for the red rag appeared no where on the ſurface of the ſnow.

4.—Tried a plug made with ſprings, in the manner of a ſearcher, only very ſhort and ſtrong. Added the freezing mixture. The ſhell gave a ſudden crack at a quarter after nine, and inſtantly ſhot from its ſurface two thin plates of ice, reſembling fins, about 2 inches in the higheſt parts. On examining the ſhell I found it burſt, and the plug forced up about half an inch; and, on breaking the ſhell, the ſprings were conſiderably bent, ſo as not to have recovered their firſt ſituation.

9.—Repeated the laſt experiment, with a ſimilar plug and the freezing mixture. It was thrown out, as before, and the projecting icy cylinder was $3\frac{1}{4}$ inches high.

Similar experiments were afterwards made with all the leſſer ſhells; yet, though one or more of each ſort were actually burſt, more plugs were projected than produced that effect. As ſoon as the ſnow began to diſappear from the ſurface, I ſearched carefully for the plugs, and found ſix of them; which, being all marked with notches *after* the firſt experiment, I eaſily formed from them the following table.

Plug,

Plug, No. 1.	Dec. 22.	22 feet.	$3\frac{1}{2}$ to the right of the line of direction.
3.	24.	62	5 left.
4.	31.	387	$2\frac{1}{2}$ right.
5.	Jan. 2.	415	$3\frac{1}{2}$ right.
6.	4.	Shell burst.	
7.	9.	325	$4\frac{1}{2}$ left.

SUCH was the result of these experiments, from which I leave it to you to draw conclusions. I intend to pursue them again this winter; and, if you can suggest any ideas on the subject that can reach Canada before March 1786, I shall be glad to avail myself of them.

ED. WILLIAMS.

REMARKS *on the preceding Extract by* CHA. HUTTON, LL. D.

FROM these ingenious experiments, we may draw several conclusions. As,

First, WE hence observe the amazing force of the expansion of the ice, or the water, in the act of freezing; which is sufficient to overcome perhaps any resistance whatever; and the consequence seems to be, either that the water will freeze, and, by expanding, burst the containing body, be it ever so thick and strong; or else, if the resistance of the containing body exceed the expansive force of the ice, or of water in the act of freezing, then, by preventing the expansion, it will prevent the freezing, and the water will remain fluid, whatever the degree of cold may be.

THE amazing force of congelation is also obvious from the distance to which the iron plugs were projected. For, if we consider the very small time that the force of expansion acts on the plug in pushing it out, and that the plug, of $2\frac{5}{8}$ lb. weight, was projected with a velocity of more than 20 feet in a second of

of time, and thrown to the diſtance of 415 feet by this force; ſo acting, the intenſity of the force will appear to be truly aſtoniſhing.

2dly, We may hence form an eſtimate of the quantity which the water expands by freezing. For the longeſt cylinder of ice was obſerved to be $8\frac{1}{2}$ inches without the hole; to this add $1\frac{1}{2}$, the thickneſs of the metal, or length of the hole, and the ſum, or 10 inches, is the whole length of the cylinder of ice, the diameter of which is $1\frac{7}{10}$ inches; and hence its ſolid content is $1.7^2 \times 10 \times .7854$ cubic inches.

But the diameter of the ſpherical cavity, filled with water, is $9\frac{1}{10}$ inches; and therefore $9.1^3 \times \frac{2}{3} \times .7854$ is the content of the water in cubic inches.

Hence then the content of the water is to the increaſe by expanſion, as $\frac{2}{3}$ of 9.1^3 to 10 times 1.7^2, or as 502.4 to 28.9, or as 174 to 10. So that the water, in this inſtance, expanded in freezing, by a quantity which is between the 17th and 18th part of itſelf.

C. H.

VI.

VI. ABSTRACT *of* EXPERIMENTS *made to determine the* TRUE RESISTANCE *of the* AIR *to the* SURFACES *of* BODIES, *of various figures, and moved through it with different degrees of velocity. By* CHARLES HUTTON, LL.D. *Professor of Mathematics in the Royal Military Academy, Woolwich, and* F. R. S. LOND. & EDIN.

[*Read by Mr* ROBISON, *Jan.* 1. 1787.]

1. THE experiments from which the following are extracted, make part of a course, instituted at the Royal Military Academy, for determining the resistance of the air to a surface of any form whatever, either plane or curved, moved through it with any degree of velocity. I was induced to undertake these experiments, both for the improvement of my students in the Academy, and with a view to apply the conclusions derived from them towards perfecting the theory and practice of military projectiles, as well as other branches of natural philosophy, in which the pressure or resistance of fluids is concerned: Circumstances, concerning the laws of which, authors on the theory have widely differed; some making the pressure or resistance equal to the weight of a column, whose altitude is equal to the whole height due to the velocity, while others make the altitude very different, either the half or the double of that. This altitude, however, it is evident, will be various, according to the nature of the fluid, whether elastic or non-elastic, *&c.* or according to its different degrees of compression. I have, therefore, confined these experiments to the pressure and resistance of the air only, being that which affects the

the accuracy of the branch, for the improvement of which I am more particularly ſolicitous at this time; and therefore the laws here deduced are not meant to be extended to other fluids of a different nature.

2. THE machine with which theſe experiments were performed, was made after the pattern of, and by the ſame workman as that which is deſcribed by the late excellent Mr ROBINS, in the firſt volume of his works, as publiſhed by Dr WILSON, and of which a view is inſerted in that volume, at leaſt of the principal parts of it. Suffice it, therefore, in this place, juſt to obſerve, that it conſiſts of a ſmall vertical axis, with a long horizontal arm connected with it. A body of any form is fixed on the extremity of the arm; then a fine, but ſtrong ſilken thread, or cord, is wound about the axis, with a given ſmall weight at the end, which is paſſed over a vertical pully, and left to deſcend by its weight, and ſo turning the axis, gives motion to the arm and body at the end of it. Hence it is evident, that a ſlow motion of the axis, or of the actuating weight, will give a very quick motion to the reſiſting body at the end of the arm; this latter being to the former indeed, as the length of the arm, meaſured to the centre of the body, is to the radius of the axis, which, in theſe experiments, was as $51\frac{1}{7}$ to 1.

3. THE actuating weight would deſcend continually with an accelerated velocity, were it not for the friction of the axis, and the reſiſtance of the air to the arm and the body placed at the end of it. But this reſiſtance always increaſing with the velocity, and indeed as the ſquare of it, it muſt needs happen, that, by the reſiſtance conſtantly gaining on the velocity, this will ſoon arrive at its maximum, and after that proceed with a uniform motion, the reſiſtance neither gaining on the velocity, nor the velocity on the reſiſtance, but each mutually balancing the other. As ſoon as this happens, then the actuating

tuating weight is the meaſure of the reſiſtance of the air on the body and the arm, and of the friction of the axis.

4. Next, to find what part of the retardation is owing to the friction on the axis, and the reſiſtance of the air againſt the arm, both the actuating weight and the reſiſting body were taken off, and, inſtead of the latter, a very thin bit of lead of the ſame weight was put on; then various ſmaller actuating weights were employed, till at laſt ſuch a one was found as gave to the machine the very ſame degree of uniform motion as it had before, when the reſiſting body and the larger actuating weight were employed. Then, the degree of velocity being the ſame in both caſes, the ſmaller actuating weight will be the meaſure of the friction on the axis, and the reſiſtance of the air to the arm; both of which, however, were reduced to as ſmall a quantity as poſſible, the former by means of friction-wheels, and the latter by being made thin and feather-edged.

5. Subtracting now the leſs weight from the greater, the remainder is the meaſure of the reſiſtance of the air againſt the body alone; that is, when reduced for the different lengths of lever, namely, by diminiſhing the remaining weight in the ratio of the length of the arm to the radius of the axis, meaſured to the middle of the thread. Thus, then, we obtain a weight which is the meaſure of the reſiſtance of the air againſt a given ſurface, moving with a given velocity; that is, a weight which is equal to the preſſure of the air againſt the ſurface, or which, if it were laid upon and uniformly diffuſed over the ſurface when it is a plane, would preſs the ſurface juſt as much as the air does.

6. Then, laſtly, finding what altitude a column of air muſt have, which is of the weight of the aforeſaid remaining weight reduced, and whoſe baſe is the plane of the reſiſting ſurface; it will be the altitude of the column of the fluid whoſe weight or preſſure is equal to the reſiſtance, and which preſſure would conſequently generate the ſame velocity in the fluid.

7. The

7. The body uſed to affix to the end of the arm, in the following abſtract, was a hemiſphere of paſteboard, the hollow part being covered with a flat circle of the ſame, that either the round or the flat ſide might be made to go foremoſt againſt the air. The diameter of the hemiſphere was $6\frac{3}{8}$ inches; and conſequently the area of its great circle, or flat ſide, was 32 ſquare inches or $\frac{2}{9}$ of a ſquare foot, and it weighed 4 oz. 3 dr. avoirdupois. The hemiſphere being fixed on the end of the arm, with either ſide foremoſt, by a medium of ſeveral times, and different ways of meaſuring, it was found, that the radius of the axis, including half the thickneſs of the thread, was 1.043 inches, and the length of the arm, meaſured to the centre of the hemiſphere, was 53.34 inches; ſo that the two radii, namely of the path of the body and of the axis, are to each other as 53.34 to 1.043, or as 51.14 to 1: And therefore every experimented actuating weight muſt be divided by 51.14 or $51\frac{1}{7}$, to reduce it to the equivalent weight acting at the centre of the hemiſphere.

8. The times of revolutions of the arm were counted by a peculiar pendulum clock, beating ſeconds, which was made for the purpoſe. The method was thus: The clock being placed cloſe by the machine, and the hemiſphere and actuating weight fixed in their places, an aſſiſtant held the hemiſphere in a particular ſituation by his hand, while a ſecond aſſiſtant audibly counted the beats of the clock, beginning at 50 ſeconds, and counting on from 1 to 10, which conſequently would end at 60 or 0; and the inſtant he pronounced 10, the firſt aſſiſtant let the hemiſphere go. The conſequence was, it began at firſt to move very ſlowly, and gradually increaſe for a ſhort time, and then to move uniformly. The firſt aſſiſtant, keeping his ſtation, called out at every time the body paſſed him, in its revolution, and the other aſſiſtant called out the correſponding number of ſeconds and half ſeconds beat by the clock, which I inſtantly wrote down with a pencil on a paper held in my hand,

hand, previoufly ruled for that purpofe. And thus we could with eafe mark the precife time of every revolution. The number of revolutions was ufually continued to about 35; and as the motion, with the hemifphere commonly became uniform after two or three revolutions, and with the lead only, after about 20 revolutions, I fubtracted the time of the firft 25 revolutions from that of 35, and the remainder was the mean time of 10 revolutions; and, confequently, dividing by 10 gave me the mean time of one revolution very correctly; and thence, from the fpace of one circle or revolution, which is 27.93 feet, the velocity of the hemifphere *per* fecond of time.

9. In this manner, then, by varying the actuating weight, by 1 dr. or 2 dr. *&c.* at a time, I obtained a long feries of correfponding times and velocities, both with the round and flat fide of the hemifphere foremoft, and with the equivalent lead only. After which I fubtracted the numbers of this latter from the correfponding ones of the two former, and the remainders, when divided by 51.14, gave the true meafure of the preffure of the air at the centre of the hemifphere.

In the following table are felected only the velocities in whole numbers of feet, namely, of 3 feet *per* fecond, of 4 feet, of 5 feet, and fo on to that of 20 feet *per* fecond of time, with the correfponding actuating weights in all the three cafes, namely the flat fide foremoft, the round fide foremoft, and without the hemifphere, with the lead only; namely, fuch actuating weights as were really experimented, and before dividing them by 51.14, to reduce them to the centre of the body.

ABSTRACT of VELOCITIES and ACTUATING WEIGHTS.

Velocity, *per* sec.	Weights with Flat side.	Round side.	Lead only.	Diff. or true resistances. Flat.	Round.	Ratios.
feet.	oz.	oz.	oz.	oz.	oz.	
3	3.8	2.2	1.2	2.6	1.0	2.60
4	6.2	3.4	1.4	4.8	2.0	2.40
5	9.2	4.9	1.7	7.5	3.2	2.35
6	12.8	6.7	2.0	10.8	4.7	2.30
7	17.0	8.7	2.3	14.7	6.4	2.30
8	21.9	11.0	2.8	19.1	8.2	2.33
9	27.6	13.5	3.3	24.3	10.2	2.38
10	34.0	16.2	3.8	30.2	12.4	2.44
11	41.0	19.2	4.4	36.6	14.8	2.47
12	48.7	22.6	5.1	43.6	17.5	2.49
13	57.1	26.4	5.8	51.3	20.6	2.49
14	66.2	30.6	6.5	59.7	24.1	2.48
15	76.0	35.1	7.2	68.8	27.9	2.47
16	86.6	40.0	7.9	78.7	32.1	2.46
17	98.2	45.3	8.7	89.5	36.6	2.45
18	111.0	51.0	9.5	101.5	41.5	2.45
19	125.0	57.2	10.3	114.7	46.9	2.45
20	140.0	64.0	11.0	129.0	53.0	2.44
1	2	3	4	5	6	7

HERE the first column contains the velocity *per* second; the second column contains the experimented actuating weight, with the flat side foremost; the third column that for the round side foremost; and the fourth column that for the lead only: Then the fifth column contains the difference between the second and fourth, or actuating weights for the flat side and lead; and the sixth column the difference between the third and fourth, or actuating weights, for the round side and lead only; so that the fifth and sixth columns, when divided by $51\frac{1}{7}$, will be the true measure of the resistance of the air to each side of the

the hemiſphere, moving with the correſponding velocity on the ſame line of the firſt column; and in the laſt column are contained the ratios of theſe two reſiſtances, or how often each reſiſtance of the round ſide is contained in that on the flat ſide of the hemiſphere.

10. FROM a ſlight contemplation of the laſt three columns of this table, we may eaſily draw ſeveral important conſequences. As, *firſt*, From the fifth and ſixth columns, it appears, that the reſiſtance to either ſurface, with different velocities, is always as the ſquare of the velocity, as near as ſuch experiments can be expected to ſhow.

THUS, in the fifth column, taking the reſiſtances correſponding to the velocities of 4 feet and 8 feet, which are as 1 to 2, and their ſquares as 1 to 4; the reſiſtances 4.8 to 19.1 are as 1 to 4 very nearly; and the reſiſtances in the ſixth column, namely, 2 to 8.2, are alſo nearly in the ſame ratio. And ſo of others.

11. *2dly*, FROM the laſt column, it appears, that the reſiſtance to the flat ſide is to that on the round ſide, on an average, nearly as 2.45 to 1, or 2½ to 1 nearly, if a medium be taken among all the numbers in the laſt column. But, by the theory of the reſiſtance of fluids, we are led to expect, that this ratio would have been only that of 2 to 1, inſtead of 2½ to 1, as by the experiment. Now, what this difference is owing to, may be at preſent difficult to determine with preciſion. The greater part of it may probably ariſe from the air differing in its nature from the perfect fluid which the theory contemplates; but ſome ſmall part of it may ariſe from the different figure of the hinder parts of the hemiſphere, though I hardly ſuſpect that this may cauſe any ſenſible difference. I intend, however, ſoon to try whether it be ſenſible to experiments; in which I intend to employ a cylinder, to compare with the flat ſide foremoſt of the hemiſphere, and a whole ſphere, each of the ſame diameter, to compare with the round ſide foremoſt of the hemiſphere. I

 propoſe

propose also, at the same time, to try the resistance of some other figures.

12. *3dly*, FROM any of the numbers in the sixth column, it appears, that the altitude of a column of air, whose pressure is equal to the resistance on the round side of the hemisphere, is half the altitude due to the velocity of the figure; that is, half the altitude from which a body must freely fall by gravity to acquire that velocity; and, in this instance, agreeing with the theory. Thus, if we take the velocity of 10 feet *per* second, whose resistance in the sixth column is 12.4, we shall have as $32^2 : 10^2 :: 16 : \frac{100}{64} = 1.56$ feet, which is the altitude due to to the velocity 10, and the half altitude is .78; but the weight is 12.4 ounces, which being divided by 51.14, to reduce it from the axis to the centre of the body, gives .2411 oz. for the true resistance to the convex side. Now, a cubic foot of air weighs $1\frac{1}{4}$ oz.; therefore, as $1\frac{1}{4} : .2411 :: 1' : .1929$, which is the bulk of the column of air whose weight is equal to the resistance, which being divided by $\frac{2}{9}$ of a foot, the area of the base, we have .86 feet for the altitude of that column, and which, therefore, is nearly equal to the half altitude above found for the velocity, exceeding it only by about the 13th or 14th part.

13. *4thly*, BUT, from the fifth column, it appears, that the altitude of the column of air, whose pressure is equal to the resistance on the flat side of the hemisphere, is to the altitude due to the velocity of the body, as $2\frac{4}{9}$ to 2, instead of being equal, as required by the theory.

VII.

VII. Observations *of the Places of the* Georgian Planet, *made at Edinburgh with an Equatoreal Instrument. By* John Robison, A. M. F. R. S. Edin. *and Professor of Natural Philosophy in the University of Edinburgh.*

[*Read by the Author, March* 7. 1787.]

	M. T. Edin.	Apt. Lon. Plan.	Er. theor.	Apt. lat. N.	Compar.
	d. h. ′ ″	s. ° ′ ″	″	° ′ ″	
1787. Jan.	12. 06. 39. 24	3. 23. 35. 17	+8	—. 32. 20	4
	15. 06. 05. 11	3. 23. 27. 44	—7	—. 32. 20	3
	17. 06. 13. 16	3. 23. 22. 17	+5	—. 32. 19	2
	18. 06. 05. 33	3. 23. 19. 42	+2	—. 32. 21	2
	20. 06. 23. 04	3. 23. 14. 24	+7	—. 32. 17	4

Hence it may be deduced, (by following the method described in a paper formerly read to this Society*) that the planet was in opposition January 13ᵈ. 04ʰ. 56′ M. T. Greenwich, in longitude, 3ˢ. 23°. 32′. 24″ from the mean equinox, with —°. 30′. 38″ north heliocentric latitude.

The error of the theory in longitude is nearly +5″, and in latitude nearly —18″.

I attribute this error in latitude to the different manner in which I observed the declinations. I formerly observed the difference of declination between the planet and fixed star by means of a common micrometer. But I was obliged to substitute Dr Bradley's rhombus for my micrometer, which had received an injury which I could not get repaired in time. If this be allowed, the error in longitude will be diminished nearly 2″.

My telescope has an achromatic object glass of 44 inches focal distance, magnifies 19½ times, and takes in a distinct field of 92′.

* Transactions of the Royal Society of Edin. Vol. I. N° XI. Phys. Cl.

92′. The planet was always compared with at leaſt two ſtars, which paſſed through the field without altering the poſition of the inſtrument. The interval between the tranſits of the fixed ſtars, compared with their difference in right aſcenſion in the tables, ſhows the error of the poſition of the horary wire; and the planet's difference in declination ſhows what portion of this error is to be applied to the time of its tranſit. When the poſition of the horary wire was very oblique to the horizon, and the altitudes ſmall, a correction was made for the difference in refraction.

Both ends of the polar axis were firmly ſupported in a ſtone wall. The teleſcope turned round on a pin within two inches of the upper pivot of the axis, and cloſe by the object glaſs. The other end of the teleſcope was ſupported (at the place of the wires) by a ſtiff rod, which turned round a pin within two inches of the lower end of the polar axis; ſo that the teleſcope, axis and this rod, formed a triangle. Another ſtiff rod was faſtened to the teleſcope at the place of the wires, with a double joint, and its other end paſſed through a ſocket, firmly fixed on the ſide of the window, where it was held faſt by a ſcrew-pin. The rod was in a plane, nearly parallel to the equator. It is eaſy to ſee that, by this conſtruction, each part of the inſtrument was expoſed to a longitudinal ſtrain alone, and all effects of the tremor of its parts were avoided. It was ſo completely free from any inconvenience of this kind, that, even in very boiſterous winds, the image of the ſtar was perfectly ſteady, and free from every kind of quivering. I never found any two compariſons of the planet with the ſame pair of ſtars differ above half a ſecond in time. As the inſtrument was ſo exact, and did not (excluſive of the teleſcope) coſt above three pounds, I thought that this ſhort account of it would be acceptable to ſuch as are not provided with thoſe expenſive inſtruments which are thought eſſentially neceſſary for making good and uſeful obſervations.

VIII.

VIII. ANSWERS *to the Objections of* M. DE LUC *with regard to the* THEORY *of* RAIN. *By* JAMES HUTTON, M. D. F. R. S. EDIN. *and Member of the Royal Academy of Agriculture at Paris.*

[*Read by the Author, Dec.* 3. 1787.]

M. DE LUC, in his *Idées ſur la Météorologie,* has made ſome objections to the Theory of Rain * which I had the honour to lay before this Society. I ſhall now endeavour to anſwer theſe objections; and hope the Society will forgive me for taking up a little of their time and attention with this ſubject. The reputation of M. DE LUC is ſo well eſtabliſhed in the republic of letters, that I muſt not neglect remarks which have the ſanction of ſuch authority; although, in the preſent caſe, they appear to me to have come from a judge who was too much preoccupied with a different ſyſtem.

THE queſtion between us, according to M. DE LUC's own ſtatement, is this, Whether or not, when two maſſes of air of different temperatures are mixed together, the humidity of the new maſs is greater than the mean between the humidities which the two maſſes had ſeparately? This I maintain to be a phyſical truth, and M. DE LUC refuſes to admit it as a rule in nature.

I HAD eſtabliſhed this propoſition, That, upon the ſuppoſition of the evaporating power increaſing with heat, but increaſing at a greater rate, the mixture of two portions of air, of different temperatures and ſufficiently ſaturated with humidity, would produce a condenſation of water which might then become viſible.

* Tranſactions of the Royal Society of Edin. Vol. I. N° II. Phyſ. Cl.

ſible. I then ſay, That this caſe properly applies to the phenomena of breath and ſteam, which give a viſible condenſation in mixing with the colder atmoſphere; and it explains the various appearances that may occur in mixing together ſeveral portions of air more or leſs ſaturated with humidity, and in different temperatures of heat and cold. For,

It is not every mixture of the atmoſpheric fluid, in different temperatures, that ſhould, according to the theory, form a viſible condenſation; this effect requiring, in that atmoſphere, a ſufficient degree of ſaturation with humidity. Neither is it neceſſary for this effect, that the two portions to be mixed ſhould each be ſaturated with humidity up to the temperature in which it then is found; it is ſufficient, that the difference in the temperatures of thoſe portions to be mixed ſhould more than compenſate the defect in point of ſaturation; but if a mixture ſhall be made of two portions of the atmoſphere, both fully ſaturated with humidity, then, however ſmall may be the difference of their temperatures, there is reaſon to believe, that a condenſation proportionate to this difference will take place.

Here it is to be obſerved, that I have made the rule abſolute, or generalized the propoſition to every ſuppoſable caſe; while, at the ſame time, I appealed to familiar examples in two caſes, that is, of humid atmoſphere and of pure ſteam, in giving the breath of animals in the one caſe, and the ſteam of a boiling kettle in the other.

The propoſition being thus made perfectly general, and concluded from experience to be a law of nature, M. de Luc has endeavoured to refute this phyſical principle, by attempting to explain, in another manner, the natural appearances upon which it has been founded. It ſhall now be my buſineſs to ſhow, that this explanation which M. de Luc has endeavoured to give of the ſubject, is founded upon nothing but inadvertency or miſapprehenſion.

He

He ſays, (parag. 585.) " Je ne ſuis point ſurpris que le
" Dr Hutton aît été frappé de ce que la reſpiration des animaux produit un brouillard dans l'air, lorſqu'il eſt humide ou froid ; j'en ai été frappé auſſi, comme d'un phénomene qui ne s'explique pas par les loix ordinaires de l'évaporation : mais il m'a paru, en même tems, qu'il étoit d'une toute autre claſſe ; qu'il n'appartenoit pas à l'hygrologie, mais à la phyſiologie ; en un mot, que les vapeurs qui s'y manifeſtent, ne procèdent pas de l'évaporation d'une eau contenue dans les poumons. Ceci étant lié à quelques idées ſur la nature des cauſes de la pluie, j'en renvoie le dévelopement à une autre lieu, parce qu'il formeroit ici une trop longue digreſſion, et que d'ailleurs, ſi j'examine les faits rapportés par le Dr Hutton, ce n'eſt que relativement à l'hypothèſe fondamentale elle même, et non à ſes conſéquences dans la Théorie de la Pluie ; puiſqu'on a vu, que cette hypothèſe pourroit être admiſe, ſans que la pluie pût en être la conſequence, vu l'état ordinaire de l'air."

As in this paragraph is contained all the objection that M. de Luc, ſo far as I can perceive, is able to make againſt the Theory of Rain, it will be proper to examine it particularly, and divide it into the two different propoſitions which it contains. Theſe are, *firſt*, a denial of the general principle, with regard to the condenſation of humidity in the atmoſphere, as not being a true principle, or properly founded ; and, *2dly*, a refuſal of the application of that general principle, ſuppoſing it true, to the theory of rain. Of theſe, then, in their order.

With regard to the *firſt*, M. de Luc admits all that I could poſſibly propoſe to draw from this example, *viz.* That moiſt air, breathed from the lungs of an animal into the colder atmoſphere, produces a condenſation of water, in proportion to the ſaturation of the atmoſphere with humidity, and alſo to its degree of cold below the heat of the breath ; for he acknowledges,

ledges, that he had alſo been ſtruck with that appearance, which he thought inexplicable by the ordinary laws of evaporation and condenſation. But, ſays he, it is not to be admitted as a fact to prove the ſuppoſed propoſition. Why? Becauſe it does not belong to hygrology, but to phyſiology.

I SHOULD have been at a loſs what to have replied to this objection, had not M. DE LUC, in ſome meaſure, explained himſelf in the next ſentence; where he ſays, that the vapours which are manifeſted in this caſe, do not proceed from the evaporation of water contained in the lungs. Here, then, it is evident, that M. DE LUC leaves the ſubject in hand, the condenſation of the breath, to enquire after the cauſe of its humidity. But whatever be the cauſe of this aqueous vapour in the breath, there is certainly no queſtion about its effect; that is, the humidity of the warm expired air, which is to be mixed with the atmoſphere, and there to produce miſt. I do not, therefore, ſee how any argument can be founded upon this ſuppoſed operation of the lungs, whatever it be, any more than upon that of the heart, the liver or the kidneys. In our meteorological enquiry, we ſurely are no ways concerned about the compoſition or decompoſition of water; a ſubject of chemical enquiry: We only want to explain the condenſation of that humidity which is on all hands allowed to be in the breath.

THE queſtion which, in this caſe, ſhould, according to the rules of ſcience, have been either acknowledged or denied, was this, Does the moiſt air, expired in breathing, form a condenſation of water, in being mixed with cooler air ſufficiently ſaturated with humidity? M. DE LUC has evaded making any direct anſwer to that queſtion, in propoſing to develope the ſubject upon ſome other occaſion. This may have ſuited the conveniency of our author, who was buſy in forming a meteorological theory very different from that which I had propoſed; but he had undertaken to diſprove my propoſition, with regard to the condenſation of vapour; and this viſible condenſation of the

the breath is the natural phenomenon which is to be explained, or the ſcientific experiment by which the theory which M. DE LUC refuſes, is approved.

IT may be proper here to obſerve, that I only conſider the diſſolving power of air with reſpect to water, in order to contraſt it with the precipitation of the diſſolved ſubſtance, when the action or effect of heat has been diminiſhed according to the theory. It no ways concerns my propoſition, whether it is upon the principle of diſſolution or ſimple expanſion by heat, that the aqueous vapour is retained in the air, or preſerved in a tranſparent ſtate. The expreſſion of diſſolution beſt anſwered my purpoſe, where the ſaturation of the atmoſphere with humidity was to be expreſſed; therefore I retained it, although I had declared in this Society, when my firſt paper was read and converſed upon, that I did not mean in the leaſt to enter into that queſtion which Profeſſor ROBISON then put. In like manner, it is abſolutely indifferent to the theory, whether the inſpired air or breath acquires its humidity by evaporation, diſſolution, or chemical reſolution and compoſition: Therefore, if this negation, with regard to the origin of water, be intended by M. DE LUC as an objection to my propoſition, which I think has no relation with that ſubject, it would be proper he ſhould ſhow in what reſpect that argument of his affects the condenſation of the water contained in the breath, when that breath is mixed with another portion of air.

I NOW proceed to the *ſecond* propoſition of M. DE LUC, which is, That, ſuppoſing my hypotheſis admitted, it does not follow that rain happens in conſequence of this cauſe; the ordinary ſtate of the atmoſphere being, as he alleges, too dry to admit of this effect. Now, this may be a very good reaſon why it ſhould not always rain, or ſhould not rain in that particular ſtate of the atmoſphere which is moſt ordinary; but I believe it will be difficult to perſuade thoſe who admit of the hypotheſis, that they ſhould not apply this principle in the caſe

of rain, which ſurely does not happen in the moſt ordinary ſtate of the atmoſphere, at leaſt not in moſt countries, thoſe particularly in which M. DE LUC has made his meteorological obſervations.

HAVING thus diſcuſſed the caſe of humid air or natural vapour, M. DE LUC next proceeds to conſider the caſe of ſteam, or pure vapour, as he calls it. Here he ſays, that the miſt formed above water boiling in the open air, may be explained upon another principle than that of the hypotheſis from whence I had concluded that it ſhould be ſo. It will be proper to give his reaſoning upon the ſubject:

"La vapeur de l'eau bouillante (*ſteam*) eſt pure, parce "qu'au degré de chaleur de cette eau, les vapeurs ſont toujours "capable de ſupporter ſeules la preſſion de l'atmoſphère. Des "vapeurs preſque pures, forment les bulles qui traverſent ſans "ceſſe l'eau bouillante; et ces bouffées de fluide élaſtique tranſ-"parent, deplacent l'air en ſe dégageant de l'eau. Si ces va-"peurs ſe répandent dans un éſpace qui n'aît qu'une petite "iſſue à l'oppoſite de leur entrée, en amenant cet eſpace à leur "température, elles en chaſſent tout l'air, et y demeurent tranſ-"parentes; mais dès qu'elles l'ont dépaſſé, et qu'elles ſe repan-"dent dans l'air exterieur, leur courant s'y décompoſe bientôt: "car dès la première perte ſenſible qu'elles éprouvent dans le "degré de chaleur auquel eſt attachée leur exiſtence, ne pou-"vant plus ſupporter la preſſion de l'atmoſphere, elles ſe tranſ-"forment en un brouillard, qui ſe mêle à l'air environnant."

HERE M. DE LUC conſiders the tranſparent ſteam, when coming in contact with the colder atmoſphere, as cooled by the air, without noticing, that it proportionably heats that air by which it is cooled. This overſight in another perſon but M. DE LUC, might have been natural; it might even in M. DE LUC himſelf have been more excuſable, had he been leſs converſant with the important theory of latent heat which Dr BLACK diſcovered

covered long ago. But firſt to confine our attention to the cooling of the ſteam, and then to explain the appearance of condenſation from this cooling alone, is a ſpecies of reaſoning that one would not have expected from the author of the Modifications of the Atmoſphere.

THE queſtion is not, if a body of ſteam, in the 212th degree of heat, mixed with a body of air, in the ordinary temperature of the atmoſphere, ſhould preſerve its degree of heat, that is to ſay, ſhould be cooled or not; the queſtion is, If the mean heat of this mixed maſs be ſufficient to preſerve all the humidity in a tranſparent ſtate; or, If there ſhall be formed a condenſation of viſible miſt, in this caſe as well as in the other, where moiſt and warm air was mixed with the atmoſphere? Had no condenſation in this experiment been formed, the principle of condenſation, conſequently of evaporation, could not have been extended to the caſe of ſteam, or the rule of evaporation would not have been abſolute, as comprehending both the caſe of the atmoſphere and that of water by itſelf; but the condenſation actually taking place in the experiment, generalizes this law of nature with reſpect to every poſſible combination of water, air and heat. This condenſation does not happen in conſequence of the ſteam being expoſed to any preſſure which it had not ſuſtained before, but becauſe the heat of the mixed maſs, which is the medium between the heats of the two maſſes, is not ſufficient to preſerve all the water in the ſtate of vapour; and this is preciſely what, according to the theory, the experiment is meant to prove.

BUT M. DE LUC, though he has had recourſe to the cooling of the ſteam alone, to account for the miſt which inſtantly appears upon the mixing of the ſteam and air, does not loſe ſight of the heat which he knows is not loſt; but he brings it into action again, for the evaporation of that miſt which has appeared. It is neceſſary to give his reaſoning in relation to that ſubject. " Cependant ces vapeurs décompoſées ont augmenté

" la

" la chaleur de l'air, et bientôt par-là elles y ſubiſſent une " nouvelle évaporation, qui les fait diſparoître de nouveau. " Ainſi ce phénomène rentre dans le cas général, d'une preci- " pitation momentanée, ſuivie d'une nouvelle évaporation, " quand des vapeurs, ou pures, ou mêlées à l'air, viennent à " dépaſſer leur *maximum*, par l'action d'un air moins chaud " qu'elles; ſi du moins leur production n'eſt pas aſſez rapide, " pour ſurmonter la cauſe de nouvelle évaporation qui naît en " même tems de la nouvelle chaleur acquiſe par cet air."

THE ſubject at preſent under conſideration is the evaporation of that viſible miſt which is formed by the mixture of the ſteam and air; and it is to be obſerved, that the general law of evaporation which M. DE LUC attacks, has been inveſtigated by means of the viſible condenſation of water which had been evaporated. M. DE LUC would make it appear, that, upon this occaſion of ſteam mixed with air, the viſible condenſation in the atmoſphere was not formed according to the rule which here is generalized; becauſe, ſays he, that water is again evaporated by means of the heat which the ſteam had communicated to the air.

BUT this explanation which M. DE LUC has offered to account for the evaporation again of the viſible miſt, appears to be inconſiſtent with his theory reſpecting the condenſation of the ſteam. For, if the condenſation of the ſteam be the effect of its being cooled by the air, while the air is neceſſarily heated by it, How could the former ſtate of things be reſtored without an aſſignable reaſon, or any known cauſe? that is to ſay, How could the air reſtore to the water that heat which it had received by communicating with the ſteam? or, How could the condenſed ſteam receive from the air any heat, or rob it of that portion of heat which it had before imparted, and which is now neceſſarily required for its evaporation? Here, ſurely, would be an effect without a cauſe, or a cauſe producing two oppoſite effects.

BUT

But though not in consequence of his theory, M. de Luc seems to adduce that explanation in confirmation of it. Now, if this explanation should be admitted, it might tend to confirm his supposition, that the steam had been condensed, not by the medium temperature of the mixed air and vapour, as I contend, but by the air abstracting the heat of the steam, without mixing with that steam. It is, therefore, necessary, that I should answer that supposition with regard to the evaporation of the mist. But it requires strict attention to many circumstances, in order to see, in a just light, that atmospheric operation, which had led a natural philosopher to make a supposition of that kind.

Steam, before it can be condensed into water, must communicate or transfer its latent heat (equal to 900° more than the heat of boiling water) to the body by which it is cooled or condensed; consequently, if the dissolving or evaporating power of heat proceeded uniformly with its distending power or sensible heat, the mixed mass of air and steam should still remain transparent, without producing mist or condensation. For the steam loses no heat but what the air gains; it is in the contact of those two fluids that this cooling happens; and it is in this place precisely that the condensation is produced. But there would be no condensation, if water could be retained transparent, elastic or dissolved, in the medium heat which is produced at the contact of those two bodies. Therefore, the condensation, which actually happens, proves this physical truth, that when a mass of steam is mixed with a particular mass of the atmosphere, or with a certain portion of the atmospheric fluid, the humidity of the new mass is greater than the mean between the humidities which the two united masses had separately.

I might now content myself with this observation, That it is only with the production of mist or visible vapour that my proposition is concerned, and not with the dissolution of that mist again, when it comes to be mixed with another portion of the

the atmoſphere which is not ſaturated with humidity. But I have to ſhow, that M. DE LUC has not reaſoned accurately in explaining the reaſſumption of the viſible miſt into the tranſparent atmoſphere. For, though this fact has no immediate connection with the queſtion in diſpute, the condenſation of vapour; yet it might be brought in to affect that queſtion, by a ſort of reaſoning, which, though not ſcientific, would be ſpecious.

THE miſt or viſible vapour, according to that reaſoning of our author, is evaporated by the heated air: Therefore, that vapour ought not to have been condenſed; but it was condenſed; therefore it muſt have been condenſed upon ſome other principle than that which I have alleged is general to all evaporation and condenſation of humidity. Thus, M. DE LUC would, in effect, though not in terms, make this condenſation to be no condenſation, or not the condenſation in queſtion, becauſe it is not permanent. It is evident, however, that this precipitation of the evaporated water is permanent, ſo long as the conditions of its condenſation are continued or remain. But in this caſe of ſteam emitted into the open air, thoſe conditions of condenſation cannot continue; they muſt be changed, and the condenſed vapour muſt be again evaporated, ſo ſoon as it meets with a ſufficient quantity of air under-ſaturated with humidity. Therefore, M. DE LUC has endeavoured to explain the evaporation of the viſible miſt in this caſe, upon a falſe principle, by not taking into conſideration the quantity of under-ſaturated air, which the aſcending vapour meets with in the atmoſphere.

THUS, whether we conſider the explanation which M. DE LUC has endeavoured to give, of the condenſation of miſt in the caſe of ſteam mixed with a body of air, or of the evaporation of that miſt again when riſing in the atmoſphere, there appears to be no ſolid reaſon for his objection to the theory; and I muſt be allowed to maintain, that here alſo, in the caſe of pure vapour, or ſteam mixed with a portion of the atmoſphere,

ſphere, the rule is abſolute, or the aſſumed principle with regard to the particular modification of the law of heat, is perfectly confirmed, at the ſame time that it is generalized, in being applied to every ſpecies of vapour and atmoſpheric mixture.

I CONSIDERED the two examples of breath and ſteam as ſufficient to confirm the principle with regard to aqueous condenſation and evaporation, ſeeing that they comprehended every poſſible caſe, ſo far at leaſt as the theory was concerned. But, in thoſe examples, the appearance was only that of miſt, or viſible condenſed vapour, which correſponded to cloud, and not immediately to rain. I therefore thought it neceſſary, in order to overcome the ordinary prejudices of mankind, to give an example ſeemingly more in point, although perhaps ſuperfluous, as it follows ſo plainly from the principle. There is, however, ſomething ſo convincing in the appearance, when a ſhower of rain is formed artificially in a chamber of experiment, that even a philoſopher finds himſelf better ſatisfied, after ſeeing the fact, than by many arguments, by which all the ſteps of the operation might be explained, and every effect foretold. I therefore gave two examples of this ſort, which had come to my knowledge. It is concerning theſe that we are now to examine what M. DE LUC has ſaid, (parag. 587.)

" Le ſeul des phénomènes cités par le Dr HUTTON, qui aît
" un rapport immediat avec ſa théorie, eſt la précipitation nei-
" geuſe des vapeurs répandues dans l'air chaud d'une chambre,
" lorſque cet air vient à communiquer à un air exterieur très-
" froid. Mais la preuve qui ſemble en réſulter en faveur de
" cette théorie, n'eſt qu'apparente ; car il n'y a pas lieu de pré-
" ſumer, que les vapeurs fuſſent à leur *maximum* dans l'air ex-
" terieur, ni à Tornea, ni à Peterſburg : circonſtance qui nean-
" moins ſeroit néceſſaire pour produire une precipitation d'eau
" d'apres l'hypothèſe ; à moins qu'on ne ſupposât encore, que
" quoique les vapeurs ne ſoient pas à leur *maximum* dans deux
" airs qui ſe mêlent, elles peuvent le dépaſſer ſenſiblement dans

" le mêlange ; ce qui exigeroit toujours plus des expériences di-
" rectes."

We have already ſeen how M. de Luc has endeavoured to explain the phenomenon, or rather to elude the queſtion, when the breath which is expired into the atmoſphere is viſibly condenſed ; but ſurely that was a phenomenon which had an immediate relation to the theory. Therefore M. de Luc is by no means warranted in ſaying, that this one, which he is now examining, is the only phenomenon of thoſe cited by me which has an immediate relation to the theory ; for, as the experiment of the breath exhibits the formation of cloud, and as cloud is generally conſidered as the immediate cauſe of rain, the formation of cloud without rain, in our experiments, is as immediately related to the theory, as the formation of rain without cloud. We are now to ſee how M. de Luc has endeavoured to elude the force of this example of the formation of rain.

The reaſon here given by our author, why the proof, reſulting from theſe examples of actual rain, is not real, but only apparent, is this, Becauſe, ſays he, there is reaſon to preſume, that the external air in thoſe two caſes was not fully ſaturated with humidity or vapour. Now, for that very reaſon, I ſay, circumſtances were juſt ſo much the more unfavourable for condenſation ; conſequently, if condenſation actually takes place in this unfavourable caſe, *a fortiori* it muſt be allowed in others where circumſtances may be more favourable for that operation. It is therefore evidently my intereſt, ſo far to allow M. de Luc his ſuppoſition with regard to the ſtate of the external air. But how that ſhould require more proof, or more direct proof, on my part, I am at a loſs to conceive ; as I think that I have, on that very account, good reaſon to demand of M. de Luc better arguments, or more direct proof, againſt the theory. M. de Luc, indeed, gives a reaſon for this demand of his, in the next ſentence ; but it is a very different one from that

that which he had already given. It is this, "Car d'ailleurs, "les phénomènes dont il s'agit peuvent s'expliquer ſans avoir "recours à cette hypothèſe." Here, indeed, is a very good reaſon for objecting to the application of thoſe experimental caſes; and now we are to examine this explanation which M. DE LUC is to give of the phenomenon.

HE ſays, "La maſſe (comparativement fort petite) de l'air de "la chambre, perdoit très-promptement une quantité ſenſible "de ſa chaleur par l'ouverture qu'on y faiſoit, ſans que l'air "extérieure ſe réchauffât ſenſiblement à cette ouverture, auprès "de laquelle l'air qui commençoit à s'échauffer, faiſoit bientôt "place à de l'air froid, en s'élevant. Les vapeurs chaudes de-"voient donc ſe précipiter en brouillard dans la chambre; par-"ceque l'air exterieur n'en recevoit preſque point."

THE explanation which M. DE LUC has here attempted, either is not conceived with that diſtinctneſs of idea which is required for inveſtigating the laws of nature, or is not expreſſed in ſuch preciſe terms as might make it eaſy to bring his propoſition to a ſcientific iſſue, in applying principles. Let us, however, endeavour to follow the argument of our author through the obſcurity in which it is involved.

M. DE LUC ſays, that the air of the chamber would quickly loſe a ſenſible quantity of its heat, without the external air being ſenſibly heated at this opening. Does he mean, that the air of the chamber would ſuffer any loſs of its heat upon this occaſion, beſides what happened by the interchanging of the external and internal air? Such a ſuppoſition as that might truly form the foundation of an argument; but this, it is found, will not conform to the laws of hydroſtatics. He, therefore, muſt be obliged to ſuffer ſome of the heated air to eſcape, and its place to be ſupplied with the cold air which comes in. Things being in this ſtate, our author ſays, that the warm vapours ought to precipitate, in forming miſt in the chamber, becauſe the external air receives ſcarce any of them. This evidently

dently is to have again recourſe to the fallacious argument, already diſcuſſed, of a cold body cooling a warm body, without being warmed; and it is to ſuppoſe a ſhower of ſnow produced in the warm air of the chamber, by the introduction of cold air, without that cold air mixing with the warm. But how is one body of air ſuddenly to cool another body of air, without their mixing together? At leaſt, it is as natural for thoſe two bodies to be mixed together as to form a medium temperature; and if M. DE LUC is to found an argument upon any of thoſe events not happening in that manner, he ſhould point out ſome other reaſon for his ſuppoſing that they do not mix, than that of their forming a condenſation of humidity; an event which ſhould happen, according to the principle we have endeavoured to eſtabliſh; a principle which M. DE LUC would perſuade us to believe to be without foundation.

OUR author then forms the ſuppoſition of another ſtate of the caſe, in order, no doubt, to put things in a clearer light; but, without more accurately attending to the circumſtances of the caſe than he has done, it has no other effect, in my opinion, than to perplex the ſubject more and more. He ſays, " Si au " lieu d'une ſimple ouverture à la chambre, ſes parois euſſent " été enlevés, et que la maſſe de ſon air eût été ainſi en contact " tout le tour avec l'air exterieur, il s'y ſeroit auſſi formé un " nuage; mais alors il auroit bientôt diſparu en s'évaporant, " comme celui de l'eau bouillante diſparoit dans l'air qui l'en- " vironne."

HERE M. DE LUC does not ſeem to be ſenſible that he is only deſcribing what ſhould actually happen according to the theory. But he had juſt now given us to underſtand, that he was to explain the formation of ſnow or rain, in this caſe, upon ſome other principle than that of the propoſition which has been now ſo fully conſidered. How far he has performed that undertaking, I would willingly leave to be decided by thoſe who may be more impartial judges in this caſe. But leſt it ſhould

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be thought that I omit to anſwer any thing which M. DE LUC may propoſe in relation to this ſubject, I ſhall now examine this laſt ſtatement which he has given of the caſe, and endeavour to ſhow, that every thing which he ſuppoſes to appear, ſhould truly happen according to the propoſition which he has been pleaſed to queſtion or deny.

IN ſuppoſing the caſe of a body of warm and humid air environed by the cold atmoſphere, M. DE LUC does not here mention what degree of ſaturation or humidity he ſuppoſes in the external air. Now, upon this will very much depend the conſequences of mixing the ſmall portion of humid air with an indefinite portion of the ſurrounding atmoſphere. If we ſuppoſe, as, from other parts of his writing, M. DE LUC inclines to do, that the atmoſphere is not fully ſaturated, then all the appearances muſt follow which he has ſuppoſed; that is to ſay, that there is firſt to be a viſible condenſation in the mixture of the two airs; but as this compound maſs, or warmed air, mixes with the colder, by riſing and diſperſing in the atmoſphere, the condenſed humidity is at laſt to be totally evaporated or diſſolved in the quantity of air which is not ſaturated with vapour.

LET us now again ſuppoſe the ſurrounding atmoſphere to be fully ſaturated or impregnated with humidity, then, in mixing with it the warm humid air of the chamber, there is reaſon to conclude, that the condenſation of humidity would remain permanent, although it might not remain viſible, if in ſmall quantity and greatly diſperſed in the atmoſphere. But this will require ſome explanation.

ACCORDING to the principle aſſumed in my propoſition, it is equal portions of the unequally heated airs, that, upon mixture, ſhould produce the greateſt condenſation of humidity; and that, in proportion as a very ſmall quantity of one or other is employed, that is to ſay, in proportion to the inequality of the mixed bodies, the ſmaller quantity of condenſation will

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be produced. Now, the mixture, whether of ſteam or moiſt air, with the open atmoſphere, in uniting with ſo much air, muſt ſoon be brought to the moſt extreme caſe of this kind, that is, to the greateſt inequality of the mixed bodies, and to the ſmalleſt quantity of condenſed vapour. Nevertheleſs, according to the rigour of the rule, no portion of warm ſaturated air can be mixed with cold air in the ſame ſaturated ſtate, without there being produced a certain quantity of condenſation, which will then remain permanent, ſo long as the proper conditions are preſerved. In like manner, as two ſaturated ſolutions of a ſaline ſubſtance, *e. g.* of nitre, in different temperatures with regard to heat, when mixed and preſerved in the ſame temperature, precipitate a quantity of ſalt, which is never reaſſumed by the water, unleſs the heat of that fluid be increaſed above the medium temperature which the mixture had produced. This laſt is a definite and a practicable experiment; the other, with the atmoſphere, is an indefinite experiment which cannot be made. And I am ſurpriſed that M. DE LUC ſhould not have ſeen the ſubject in the proper light.

IN this caſe of warm and humid air mixing with the colder atmoſphere, as for example, the vapours coming out from the vent of a malt-kiln, it is evident to obſervation, that the miſt which is delivered into the air diſappears only in proportion as it is diſperſed in the atmoſphere, that is to ſay, as it meets with unſaturated air by which it may be diſſolved. Now, this diſſolution is proved by ſome other obſervations, which it is extremely eaſy to make. Theſe are, *firſt*, that, *cæteris paribus*, it requires very little diſperſion of the miſt or viſible vapours in the atmoſphere, in order that they may be diſſolved when the air is dry; and that, on the contrary, when it is moiſt, the vapour continues viſible long after it is ſo diſperſed. *2dly*, That it re-uires a leſs difference in the temperatures of the two mixed airs to produce a viſible miſt, when the atmoſphere is moiſt than when it is more dry. So far, therefore, as this experiment

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is practicable, I think we may be allowed to say that natural appearances confirm our theory.

LONG before writing the Theory of Rain which is now in question, I had ascertained the dissolution of nitre in water, to proceed, not uniformly with the heat, but in a rate that was increasing. I had also accurately measured several of the ordinates of the curve which this progress formed, by carefully evaporating solutions saturated in different degrees of heat; and I had once some thoughts of corroborating the proposition, with regard to the rule of vapour by the measured curve, with regard to the solution of nitre. But as such analogical reasoning in physics is only proper to lead to conjecture; and as, in the case of vapour, we find the most direct proof that the rule is to increase at a growing rate with the heat, I gave nothing in my paper but what was necessary to ascertain the principle so far investigated. M. DE LUC has indeed disputed it; but any person who has read his later publications, will hardly expect, that, with his meteorological ideas, our author should, on this occasion, be altogether free of partiality.

HAVING thus answered every objection which M. DE LUC has made, it may be proper farther to observe, that it was not for want of other examples to establish the principle of heat and evaporation, that I confined myself to those which M. DE LUC has now disputed. I considered them as all unexceptionable, and as perfectly in point. I therefore thought them sufficient to establish the truth of the proposition which had been assumed. I might have referred to the mist formed in a summer evening upon meadows heated by the sun during the day, and evaporating humidity when the air grows cool; as also, to the visible smoak, in the winter season, from the surface of water, a degree or two only above the freezing point, when the atmosphere upon that surface is about 15° colder. In like manner, I might have cited the experiments wherein

wherein condenſation of vapour is formed, by mixing the atmoſpheric air with that which had been rarefied, or by emitting into the atmoſphere air which had been condenſed. In all thoſe caſes, there is the mixture of two portions of the atmoſphere, in ſufficiently different temperatures, to produce condenſation of humidity, which actually happens. Thus, all thoſe appearances are properly explained by the theory, or, as experiments, they confirm the aſſumed propoſition.

But if thus every particular example is a proof, and if each example is unexceptionable in its kind, what degree of evidence muſt ariſe from the united teſtimony of every poſſible experiment almoſt which can be adduced in relation to the ſubject? It is to be preſumed that M. de Luc, with all his extenſive knowledge of nature, could not adduce one ſhadow of a fact by which the alleged propoſition could be called in queſtion or diſproved.

M. de Luc concludes in the following manner, (parag. 588.) " Je ne vois donc rien dans ces faits, qui contribue à éclaircir " la queſtion de la pluie; et par conséquent elle me paroît " reſter au point ou je l'avois amené avant que d'entrer dans " ce nouvel examen. Je tire même du memoire du Dr Hutton, ces deux conſequences, qui juſtifient le travail que j'ai " enterpris. Quoiqu'il paroiſſe s'être beaucoup occupé des " phénomènes de la pluie, aucune théorie à leur egard ne l'avoit " ſatisfait; et d'après ce qui lui etoit connu des loix de l'hygrologie, il avoit conclu, que la précipitation de l'eau ſimplement evaporée, ne pouvoit être produite que par refroidiſſement. Or, ce ſont, entre autres, ces deux motifs qui m'ont " conduit dans mes recherches."

M. de Luc had no occaſion to juſtify his undertaking by any opinions of mine. His writings will always contain matter ſufficient to intereſt the public; and his ideas of hygrology muſt be ſupported upon their own bottom. I therefore wiſh he had not given as my ideas expreſſions which, however, in

in ſome reſpects, ſufficiently juſt, may bear perhaps another interpretation. That the precipitation of water ſimply evaporated cannot be produced except by cooling, is an expreſſion which, though not contrary to my idea, does not contain preciſely my opinion. Water is not precipitated from the atmoſphere in time of rain by the cooling of the air, in the ordinary ſenſe of that expreſſion, that is, by the abſtraction of a certain quantity of its heat, which is then communicated to ſome other body; but it is becauſe the air is not able to contain ſo great a quantity of water, in proportion to its heat, when it is in a lower temperature. The compound maſs of air, which in the formation of rain precipitates water, is not cooled, ſo far as I know, below the mean temperature of the different maſſes of unequally heated air which have concurred to form it; but this mean temperature does not ſuffice to evaporate all the water which had been contained in theſe maſſes ſeparately. This, however, is only by the by; and I now proceed to the material part of his concluſion, where he thus continues:

" QUANT à l'hypothèſe que je viens d'examiner, elle étoit " très naturelle dans l'état des faits connus; puiſqu'il n'étoit " pas poſſible de concevoir d'aucune autre manière, que des " mêlanges d'airs à differentes temperatures, puſſent produire " des pluies abondantes: et la vraiſemblance de cette hypothèſe " ne pouvoit être détruite, que par un genre d'experiences et " d'obſervations, qui ne fait que de naître en phyſique avec " l'hygromètre."

IN anſwer to this, I have but to obſerve, that, had M. DE LUC contented himſelf with ſaying, as he here has done, that the probability of this hypotheſis could not be overturned, but by a ſort of phyſical experiments and obſervations which have juſt taken their birth with the hygrometer, I ſhould have waited patiently until thoſe experiments and obſervations had arrived at that maturity which might enable them to confute my theory. But M. DE LUC has undertaken to confute it upon

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other principles, which do not require any profound knowledge of that inſtrument. It is only to theſe that I have anſwered; and I beg it to be underſtood, that the theory which I have endeavoured to eſtabliſh, is juſt now as open to the experiments of the hygrometer, whether for being ſupported by them or overthrown, as if nothing had been written upon the ſubject.

IX.

IX. *An* ACCOUNT *of a* DISTEMPER, *by the common People in England vulgarly called the* MUMPS. *By* ROBERT HAMILTON, M. D. *Fellow of the Royal College of Physicians*, F. R. S. EDIN. *and Physician at Lynn Regis, in Norfolk* *.

THE mumps, or what I beg leave to call angina maxillaris, is an epidemic diſeaſe of a very ſingular nature. It has appeared ſometimes to be pretty general; but this has not been the caſe for many years in this place. It ſeems to be analogous to, if not the ſame diſtemper with that called the branks, by the common people in Scotland. In the general account of epidemics, in the firſt volume of the Medical Eſſays of Edinburgh, a diſorder is mentioned which ſeems to have been a ſlight degree of that which is the ſubject of the following paper. I have had much practice in this diſeaſe, and indeed was once reduced to the utmoſt danger by it myſelf.

IN the following paper, I ſhall not pretend to give a ſyſtematic treatiſe on the mumps. I ſhall relate what was the reſult of obſervation, both in regard to the hiſtory and cure of this diſeaſe; and as I ſhall faithfully detail what I actually ſaw, I flatter myſelf, that this account will not be unworthy of the peruſal of future obſervers.

 THE

* This paper was read before the Philoſophical Society of Edinburgh, Auguſt 5. 1773. It is now printed by order of the Committee for publication of the Tranſactions of the Royal Society of Edinburgh.

THE hiſtory of the mumps is as follows:

A LASSITUDE, a heavineſs, a general reſtleſs uneaſineſs, not eaſily deſcribed, are perceived ſeveral days before the ſwelling which characteriſes the diſeaſe, begins to appear. Theſe diſagreeable feelings are attended with gentle rigors, and ſome degree of fever, which, being ſlight, is commonly diſregarded. Then a ſtiffneſs, with obtuſe pain, is felt in one or both ſides of the articulation of the lower jaw, impeding its motion and of courſe maſtication; which ſymptoms increaſing, a ſwelling appears upon the parts the following day, and quickly extends to the parotid glands, the neighbouring ſkin, and cellular membrane. Here, in ſome, it ſtops without diſcolouring the ſkin; and, by keeping the parts moderately warm, and cautiouſly avoiding the cold external air, the patient is ſoon freed from it, without any medical aſſiſtance. But, when this is not the caſe, the parts affected generally redden the next day, the tumor becomes more diffuſed, and ſometimes increaſes ſo ſuddenly in ſize, that, on the third day from its firſt appearance, it occupies the ſalivary glands and ſurrounding cellular membrane on that ſide; and, if both ſides are affected, the parts are ſo much ſwelled, and the tumor deſcends ſo low, that the countenance is rendered of a frightful enormous magnitude; and now deglutition becomes more or leſs impeded. All this is frequently without much pain; but moſt commonly there is now a great deal, and a conſiderable degree of fever. When this happens, the countenance appears florid, and a duſky eryſipelatous inflammation covers the tumor, which is deepeſt in colour where there is the greateſt hardneſs, *viz.* on the parotid and maxillary glands. In many ſubjects here it ends. And it ſeems probable from the natural reſolution of the diſeaſe, which now immediately follows, that the tumor has attained its greateſt magnitude,

nitude, and the diſtemper its acmé; for, about the morning of the fourth day from the firſt appearance of the ſwelling, a diſcharge begins from the emunctories behind the ears; a dew-like ſweat, frequently in large drops, iſſues from every pore of the extended ſurface of the tumor; a gentle diaphoreſis covers the body, if in bed; the inflammation abates, the ſwelling gradually leſſens, and, with theſe favourable circumſtances, the fever goes off, and the diſtemper totally diſappears about the ſixth day, if nature is not interrupted in her buſineſs. But, if the tumor ſubſides ſuddenly about the fourth day, and one or both teſticles begin to ſwell, ſometimes with much pain, heat, inflammation, new rigors, and a freſh exacerbation of fever, much is to be apprehended from this new morbid appearance, and much circumſpection is required in the treatment of it. For the means employed by nature to promote the reſolution of the tumified teſtes, are exactly ſimilar to thoſe which take place in the termination of the tumors below the ears; a ſpontaneous diſcharge iſſues from the ſkin of the parts affected, and, if this is copious and continued, and accompanied with a free perſpiration from the ſurface of the whole body in bed, the diſeaſe ends happily without farther trouble; but if it is ſcanty, partial, or interrupted by accidental cold or imprudent treatment, the tumors of the teſticles ſubſide ſuddenly, the patient becomes reſtleſs, a freſh exacerbation of fever enſues, the head is affected, delirium follows, with convulſions and other dreadful ſymptoms, and ſometimes death cloſes the ſcene.

It may be aſked, Whence does this train of ſymptoms ariſe? Is it from a tumefaction of the brain taking place in the inſtant of the ſudden diminution of the tumors of the teſtes; as we have before ſeen happen to the teſticles, when the ſalivary glands ſuddenly ſubſided?

An

An extraordinary circumſtance took place in two caſes which came under my notice. One teſticle in each perſon was found to be waſted away after the diſeaſe had ended; ſome particulars of which ſhall be mentioned in the ſequel.

The pathognomic ſigns of the mumps may be readily gathered from the foregoing hiſtory, and are the ſame with little variation. The characteriſtic tumor under one or both ears, involving the ſalivary glands, with more or leſs of a concomitant fever, is the firſt. If the diſeaſe is mild, it ſoon ends by a ſpontaneous ſweating from the ſurface of the tumor. If not, that tumor (or tumors, if on both ſides) ſubſides ſuddenly, accompanied with a freſh exacerbation of fever, and the teſticles ſwell. And here it alſo ſometimes goes no further, but terminates by a diſcharge from the ſkin covering thoſe parts. But if the teſtes ſuddenly ſubſide, and a freſh exacerbation of fever appear at the ſame time, the brain is immediately affected, attended by a train of terrible ſymptoms, and death ſometimes ends the conflict.

The mumps, ſo far as my obſervations extended, appeared generally confined to young men, from the age of puberty upwards to thirty years. Not many between thirty and forty fell under my care. I never knew above one man of forty attacked by this diſeaſe, and he ſuffered ſeverely. Very few boys were affected, and thoſe had the diſtemper mildly.

I never ſaw any of the female ſex above ten years old ſubject to this illneſs; and thoſe who fell under my care were not numerous, and generally had the diſeaſe mildly. I do not remember one inſtance of the mammæ being affected. I have, however, heard of this circumſtance; but cannot ſpeak as to the authenticity of my intelligence. But from what happens in men, it is, from analogy, moſt natural to ſuppoſe, that the ovaria are more likely to be affected than the mammæ; although there is undoubtedly a wonderful ſympathy be-

tween

tween the uterus, and we ſuppoſe its appendages, and the mammæ. On this matter, however, I ſhall not pretend to decide.

THE mumps made its appearance in an epidemic form at Lynn in 1758, and remained ſeveral years afterwards. It was chiefly confined to the ſpring months. In the year 1761, it prevailed very much. Two companies of the Norfolk regiment of militia were quartered here, and put under my care. It raged more among theſe ſoldiers, in proportion to their number, than amongſt the inhabitants of the town. I was very ſeldom without ſeven or eight of theſe men upon my liſt, ill of the mumps. After 1761, it began to decline. It, however, made its appearance in ſpring and autumn, more or leſs as an epidemic, for ſeveral years afterwards; but the number afflicted with it became gradually leſs: And ſome ſporadic caſes were to be met with many years after the epidemical appearance of it had ceaſed.

IT muſt be ingenuouſly confeſſed, that on the firſt appearance of this (to me) new diſeaſe, I was much at a loſs how to treat it. In vain I ſearched in many authors for its hiſtory and cure. That ſhort account given by Mr GOOCH, in his Caſes and Remarks in Surgery, publiſhed firſt about this time, was the only one I could find; and that was too defective to form from it any general method of cure of a diſeaſe much more formidable in its appearance here, than that mild ſpecies of it which ſeemed to have fallen under his care, and gave way ſo readily to the antiphlogiſtic method of cure. Obſervation ſoon taught me that this plan was not only inſufficient, but hurtful; and that large evacuations, with a view to reduce the tumors and promote their diſcuſſion, did oftener harm than good; the changes which take place in a bad kind of this diſeaſe, from the ſalivary glands to the teſtes, and from theſe to the brain, appearing to be more frequent and dangerous, when evacuations were freely

and

and copiouſly employed, than when they were ſparingly uſed, or not at all. Thus diſappointed by following the only method of cure I had ſeen, I determined to ſtudy the diſeaſe with attention, and endeavour to imitate nature's operations in removing it; and had the ſatisfaction to ſee all my patients recover. As the antiphlogiſtic method had not been attended with ſucceſs, I avoided bleeding, unleſs it was indicated by an uncommonly hard and full pulſe, attended with great inflammation and pain; and even then I bled but ſparingly. Indeed, as highly inflammatory ſymptoms but rarely occurred, there was ſeldom occaſion for this evacuation. The bowels were kept open by clyſters; and ſometimes a gentle eccoprotic was neceſſary for this purpoſe, but the ſtronger cathartics were never uſed. As the diſcharge behind the ears, and the ſweating from the ſurface of the tumor, ſeemed to point out nature's principal reſources in terminating this diſeaſe, theſe were carefully encouraged, by wrapping the parts in flannel; and, if theſe diſcharges happened to ſtop, or even to leſſen, with an increaſe of feveriſh ſymptoms, bliſters were applied behind the ears, ſufficiently large to deſcend from thence over the whole ſurface of the tumors, which, by opening a diſcharge from the parts immediately affected, imitated, in ſome degree, that evacuation from them which nature eſtabliſhes to relieve herſelf; and by the influence of their irritation, the diſeaſe ſeemed to reſume afreſh its ſeat in the ſalivary glands, when it had in part left them, and taken poſſeſſion of the teſtes. It was curious to obſerve this fact. Sometimes, after the ſubſiding of the tumid ſalivary glands, they have become ſwelled and painful again. When this occurred, the tumors of the teſticles became leſs painful, more relaxed, and leſſened in ſize, whilſt the brain, at the ſame time, remained perfectly free from diſorder. And this happened more than once in the ſame perſon. It was ſometimes obſerved, that, after the affection of the brain had taken

taken place upon the ſudden diminution of the teſticles, that the latter have again become tumid and painful, and that the brain, on this appearance of the diſeaſe in them, has been immediately relieved. Of this curious circumſtance, I have ſeen ſeveral inſtances; but one was remarkably ſtriking in a particular friend, to whom it occurred twice. He, however, did well; but one teſticle waſted away. Reflecting, ſoon after this paper was firſt written, (which was ſeveral years after my obſervations were begun) on the extraordinary aptitude of this diſeaſe to fluctuate in this manner, I conceived that it would be an object of the firſt conſequence, to fix the diſtemper, if poſſible, in its firſt ſituation, the ſalivary glands, until it was perfectly ended, and prevent this dangerous diſpoſition of it, to ſhift its abode. An early irritation on the parts, and diſcharge from the ſurface, appeared, from what had been obſerved of the diſeaſe, and its mode of termination, naturally to be the moſt likely means of effecting this; and bliſters, from what already had been experienced, ſeemed to be beſt calculated for this purpoſe. There could be no hazard in the trial. With this view, bliſters of a ſize ſufficient to cover the ſkin of the tumors, ſuppoſing they ſhould afterwards attain any conſiderable magnitude, were applied over the ſalivary glands, before the ſwellings had arrived at their height, or any ſpontaneous diſcharge had appeared; and ſo far was the experiment attended with ſucceſs, that I do not remember a ſingle inſtance of a ſwelling of the teſticles taking place, where this mode of attempting to keep up the tumefaction of the ſalivary glands, and anticipating the natural diſcharge, was put in execution. Wherefore, it became my conſtant practice afterwards, to apply large bliſters on the tumors as ſoon as they were ſufficiently formed to characteriſe the diſeaſe; and I had great ſatisfaction in obſerving their utility. From analogy, we may preſume, that a ſimilar mode of practice would be attended with the moſt beneficial effects, in

cafes where the tumefactions of the tefticles fuddenly fubfide, and the brain becomes affected. I never had occafion to try this; but I am fo convinced, that, in cafes of this kind, (where there is generally danger), it would be of the greateft advantage, that I fhould not hefitate a moment in covering the whole fcrotum with a blifter, or rather a bliftering cataplafm, as foon as the leaft fymptom of the head's becoming difordered appeared, with a view to recal (if I may ufe the expreffion) the difeafe from the brain to the tefticles, whilft, to relieve the latter, epifpaftics fhould, at the fame time, be fully employed over the tumefied falivary glands.

As the patients were generally relieved by a fpontaneous fweating in bed, diaphoretics of fpiritus mindereri, *&c.* with warm drinks, affifted to keep up the difcharge for a day or two, and the diftemper was foon at an end. If, about the third day, the tefticles began to fwell, without any remarkable increafe of fever, the fame method relieved them. But, if this was accompanied with a low running quick pulfe, and reftleffnefs or anxiety, more epifpaftics were applied, and the vis vitæ kept up by neurotic cordials, befide fudorifics, with a neceffary proportion of the beft of all cordials, wine, and a plentiful fweating was encouraged. The medicines employed were various, according to circumftances; and were compofed of camphire, volatile alcali, fp. mindereri, vin. antimonial. decoct. ferpentar. *&c.* with a requifite proportion of opium to abate the reftlefsnefs. The tumefied tefticles were fufpended in a bag-trufs; the colon was emptied by clyfters, if the patients were coftive; and, with this treatment, the patients generally got well about the fixth, feventh or eighth day.

It is requifite here to obferve, that although the parts affected were kept warm, and the body covered fo as to encourage a difcharge from the fkin, it was neceffary that the lungs fhould have a frequent fupply of cool frefh air; for which purpofe, the

the curtains of the bed were kept open, and a free ventilation occaſionally admitted by the door and windows of the chambers of the ſick, which had very beneficial effects.

In the ſpring of the year 1758, a gentleman of about twenty-two years of age, (of this town), of a plethoric habit, was ſeized with the mumps. The tumors of the parotid and maxillary glands were large, hard and inflamed, and accompanied with much fever. He was bled copiouſly, and took a briſk cathartic, which produced very frequent and large evacuations. The tumors ſuddenly ſubſided, and his teſticles as ſuddenly ſwelled to an enormous ſize, attended with great pain and much fever. Unfortunately, the laſt tumefaction was ſuſpected to ariſe from a venereal cauſe. The event fatally proved the contrary. In conſequence of the opinion of its being venereal, plentiful evacuations were deemed neceſſary; and accordingly bleeding and briſk purging were again repeated. The cataſtrophe was dreadful: For the ſwelled teſticles ſubſided ſuddenly the next day, the patient was ſeized with a moſt frantic delirium, the nervous ſyſtem was ſhattered with ſtrong convulſions, and he died raving mad the third day after. My affairs calling me abroad prevented my being preſent on this occaſion; but, on my return, at the end of the ſame year, I received this account from a late learned and worthy phyſician *, who attended the patient the three laſt days of his diſeaſe.

I had not many inſtances where the brain was affected. One, however, of a gentleman, in April 1762, was marked with a circumſtance ſo extraordinary, that I beg leave to give ſome account of it. This perſon was about forty years of age, of a full habit, and had been bled ſome days before any ſymptom of the mumps appeared. He was obliged to travel a journey in a chaiſe, the ſecond day after the parotid glands began to ſwell. On the day following this, the tumors of the ſalivary

* Dr Jos. Tayler.

glands had greatly increafed, were inflamed, and the patient had much fever. On the morning of the fourth day, the fwellings were very much enlarged, and the tefticles began to be affected with pain; on the evening of that day, the right one fwelled. On the fifth day, both tefticles were much tumefied; but the right one was by far the moft fo, and foon became twice the fize of the other; and the falivary glands were found to be very confiderably diminifhed. On the day following this, the tefticles were found leffened in fize, and the patient was become reftlefs, delirious, with much fever, and had paffed a very bad night; yet the tefticles did not fpeedily, nor altogether, fubfide after the delirium began. Large blifters, nervous, *&c.* medicines, with ftrict confinement in bed, agreeable to the mode of cure before mentioned, foon relieved this patient; the tefticles fwelled again, the delirium left him, the fever went off, and the difeafe gradually ceafed. The moft remarkable circumftance attending this cafe was, that the right tefticle, which was twice the magnitude of the other, and was the firft attacked, was found, after the tumors in both had fubfided, and the difeafe was at an end, to be reduced to almoft half its natural dimenfions, and kept gradually wafting, till at length a mere empty bag, confifting of the coats, only remained. The glandular body of the tefticle has been long gone; neither is the epididymis at this time (April 1789) to be felt; the empty tunics are moftly flaccid, but fometimes they contract into a flattened body of an oblong fhape, fomewhat like an almond. This body is very tender, and gives pain when inadvertently preffed, or touched with roughnefs; which pain ftrikes in the inftant up the fpermatic chord to the loins, and is exquifite for a few feconds. This, however, feldom happens, as he is particularly careful to defend this very fenfible and irritable part from injury; the fpermatic chord is contracted and feels hard to the touch; but this alfo is extremely fenfible. From all which

circumftances,

circumſtances, it may be preſumed, that the veſſels are much leſſened in diameter, and perhaps the ſpermatic artery is become impervious; but the nerves have acquired more ſenſibility and irritability. After his recovery, he found no other inconvenience from this extraordinary change than what we have named; has had two children ſince, one born in 1769, and the other in 1772, who have both healthy conſtitutions; and he now enjoys as good health as moſt men at his time of life.

Another caſe of a waſted teſticle in conſequence of the mumps, came afterwards under my inſpection.

A young man, of twenty-five years of age, of a healthy conſtitution, was, in the end of the year 1769, attacked by this diſtemper. Upon the tumid ſalivary glands ſubſiding ſuddenly, the teſticles became affected. One of them was much more ſwelled than the other, and was found, when the ſwelling was reduced, to be diminiſhed more than one half of its natural ſize, at which it remained in Auguſt 1771.

Of the great number that fell under my care, there was but one caſe which terminated in ſuppuration. This was a young militia ſoldier, of about nineteen years of age, in the year 1761. The tumor was on the left ſide, of an enormous magnitude, reaching from about an inch above the maſtoid proceſs to the ſhoulder. It was opened by inciſion, and about two pints of matter were diſcharged. The ſeat of it was entirely in the cellular membrane, no ſuppuration having taken place in the ſalivary glands themſelves. There were large ſloughs of the morbid cellular membrane ſeparated from the vaſt cavity of this abſceſs; the looſe integuments united after this very ſoon to the parts beneath, and the man got well in a ſhort time.

About the end of the year 1762, the learned and ingenious Dr Russel's Œconomia Naturæ in Morbis Glandularum, fell into my hands. There I was pleaſed to find an account of the mumps,

mumps, and glad to ſee my obſervations ſomewhat corroborated by ſuch an authority. He thinks it contagious,—" Angina hæc ex epidemicis una eſt, et contagioſa, et per totas " domos graſſari ſolet, niſi antea fortaſſe juvenes eodem morbo " laboraverint." The laſt part of this ſentence implies an opinion that people are not liable to have this diſeaſe more than once. I do not remember an inſtance of a perſon's having it a ſecond time. I have ſeen it go through a family of ſeveral children, which inclined me to think it contagious; but when I had the diſeaſe, not any one elſe in my family, which conſiſted of four children and ſix adults, was attacked by it, although my caſe was a very bad one. About twelve months after my recovery, one of my daughters, about ſix years old, had the diſeaſe, and all the reſt eſcaped. And what is ſtill more remarkable, I do not remember an inſtance, in the families where the militia ſoldiers ill of this diſtemper were quartered, of a ſingle perſon's being infected by them.

Dr RUSSEL, p. 116. relates a caſe of a patient deſtroyed by the mumps, nearly ſimilar to that given in this paper.

HIPPOCRATES, ſect. 1. book 1. of his Epidemics, appears to have deſcribed the mumps. I ſhall take the liberty to tranſcribe the paſſage from Dr FREIND's tranſlation.

" MULTIS vero aurium tumores ſubnaſcebantur, qui in alteram partem vergebant, pleriſque etiam in utramque, iiſque " febre vacuis et in erectum ſtantibus nec decumbentibus, etſi " nonnullis pauliſper incaleſcerent; omnibus abſque noxa extincti ſunt, neque cuiquam, velut ii, qui alias ſui ortus cauſas habent, ſuppurationem fecerunt. Horum autem ea fuit " natura, ut molles et laxi eſſent, magni, diffuſi aut ſparſi, ſine " inflammatione et dolore. Omnibuſque ſenſim et ſine ulla " ſignificatione evaneſcerent. Fiebant iſta quidem adoleſcentibus, juvenibus, ætate florentibus, atque horum plurimis qui " in palæſtra, et gymnaſiis exercebantur; mulieribus vero pau-

" cis

"cis contingebant. Multis tusses aridæ et inanes, quibus cum "tussi nihil educebatur, nec ita multo post voces raucescebant. "Quibusdam vero ex temporis intervallo inflammationes cum "dolore in alterum testem erumpebant, quibusdam etiam in "utrosque. Alii quidem febribus corripiebantur, nonnulli "vero sine febre persistebant. Atque adeo hæc ipsa plurimis "gravia et molesta fuere. De reliquo autem quod ad ea "attinet, quæ ad chirurgiam spectant, in his inculpate habe-"bant."

THE spring of the year 1761 was very cold and wet; and those young militia soldiers, who were most liable to this disease, were out early and late in the low damp grounds adjoining this town, to learn their manual exercise; which corresponds with this passage, "Fiebant ista quidem adolescentibus, juve-"nibus, ætate florentibus, atque horum plurimis, qui in pa-"læstra, et gymnasiis exercebantur."

TISSOT, in his Avis au Peuple, when treating of diseases of the throat, mentions a distemper which is common in Switzerland, called by the French Les Oreillons, ou Les Ourles. This is a swelling of the salivary glands, particularly the parotids and maxillaries, and appears to be a mild species of the mumps. The tumor is sometimes so large as to cause a difficulty in swallowing, and also to prevent the mouth from opening without pain. Children are more liable to it than adults; but as it is seldom attended with fever, no medicines are required. All that is necessary is, to protect the parts from the air, apply a soft poultice, to live abstemiously, especially in respect to animal food and wine, to drink a weak warm beverage, and promote perspiration. He says he cured himself in four days, with balm tea, one fourth of milk and a little bread in it. He does not mention any swelling of the testicles; therefore this probably did not happen in Switzerland, as it never does in very slight cases of this disease.

I BEG leave to conclude this paper with the following words of CELSUS:

" SÆPE vero etiam nova incidere genera morborum in qui-
" bus nihil adhuc usus ostenderit. Ut ideo necessarium sit ani-
" madvertere, unde ea ceperint; ceu sine quo nemo mortalium
" reperire possit, cur hoc, quam illo potius utatur."

X.

X. *A* BOTANICAL *and* MEDICAL ACCOUNT *of the QUASSIA SIMARUBA, or Tree which produces the Cortex Simaruba. By* WILLIAM WRIGHT, M. D. F. R. S. LOND. & EDIN. *and Physician-general in Jamaica* *.

An Historical Account of the SIMARUBA BARK.

THE first knowledge we had of the cortex simaruba was in the year 1713. Some of it was sent to France to M. LE COMPTE DE PORCHARTRAIN, the Secretary of State, as the bark of a tree, called by the natives Simarouba, which they employed with good success in dysentery.

IN 1741, M. GEOFFROY, in speaking of this bark, says, "Est cortex radicis arboris ignotæ, in Guiana nascentis, et ab "incolis simarouba nuncupatæ: coloris est ex albo flavescentis, "nullo odore præditus, saporis subamari, lentiscentibus fibris "constans, candido, levissimo, insipidoque, radicum, stipitum, "truncique ligno hærens, a quo facile separatur."

IN 1753 and 1760, LINNÆUS makes the simaruba to be a species of pistacia, or the terebinthinus major, betulæ cortice, fructu triangulari of Sloan. Jam. 289. t. 99.

IN 1756, DR PATRICK BROWNE published his Civil and Natural History of Jamaica. At page 345. he describes the terebinthinus, or birch and turpentine tree. The bark of

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* This paper was read before the Philosophical Society of Edinburgh, August 6. 1778. It is now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

the roots, (ſays he), is thought to be the ſimarouba of the ſhops.

IN 1763, LINNÆUS makes the ſimaruba to be the burſera gummifera, and refers to the piſtacia of former editions of the Species Plantarum; and to SLOAN and BROWNE, as above cited. In the appendix, a reference is made to the terebinthinus Americana polyphylla. Commelin. Hort. 1. p. 149. and to CATESBY's gum elemi tree.

M. JACQUIN viſited all the Weſt India iſlands, and made many diſcoveries of new plants. He examined the roots of the burſera gummifera, and found their bark very different from the ſimaruba bark.

IN 1772, I employed all my ſpare hours in examining the plants of Jamaica. In this delightful walk of ſcience, I diſcovered and aſcertained many hundreds of new plants which had eſcaped the diligence of former botaniſts. Amongſt others, the tree which produces the ſimaruba bark.

IN 1773, ſpecimens of the fructification were ſent in ſpirits, accompanied with a botanical account of the tree, to my late worthy friend Dr HOPE, Profeſſor of Botany in the Univerſity of Edinburgh; alſo ſome dried bark from the roots. The following year, ſpecimens, with ſimilar deſcription, were tranſmitted to my late learned and valuable friend Dr JOHN FOTHERGILL of London; who ſent them to the celebrated LINNÆUS at Upſal, as appears by Profeſſor MURRAY's Apparatus Medicaminum, vol. iii. p. 458. *, article Simaruba. Dr FOTHERGILL cauſed elegant drawings to be made of this plant; and theſe drawings I now have the honour of preſenting to the Royal Society of Edinburgh.

IT

* QUALIS vera ejuſdem arbor ſit, jamjam aubletii indagine cognoſcimus, ut tamen et mihi monere incumbat. b. LINNÆAM equitem, litteris jam anno 1776, ineunte mihi datis, antiquam aubletii elegantiſſimum opus illi innoteſceret. ſignificaſſe, Simarubam Quaſſiæ ſpecies a ſe haberi. Ille autem ſimarubæ cortex quo Cl. WRIGHT, arborem in Jamaica, vulgarem veſtitam eſſe innuit; pariter in alvi profluviis efficaci, &c.

It is here proper to remark, that this paper was read before the Philoſophical Society of this place, and committed for publication in 1778. At the time when that Society obtained the Royal Charter, I chanced to be abroad. On my return to Edinburgh, I withdrew the communication to correct and add to my account of this important article of Materia Medica.

Deſcription of the Tree.

The tree now to be deſcribed is common in all the woodlands in Jamaica. It grows to a great height and conſiderable thickneſs. The trunks of the old trees are black and a little furrowed. Thoſe of the young trees ſmooth and gray, with here and there a broad yellow ſpot.

The inſide bark of the trunk and branches is white, fibrous and tough. It taſtes ſlightly bitter. On cutting or ſtripping off this bark, no milky juice iſſues, as has been mentioned by various authors.

The wood is hard, and uſeful for buildings. It ſplits freely, and makes excellent ſtaves for ſugar hogſheads. It has no ſenſible bitter taſte.

The branches are alternate and ſpreading.

The leaves are numerous and alternate. On the upper ſide, they are ſmooth, ſhining and of a deep green colour; on the under ſide, they are white.

The flowers appear about the beginning of April. They are of a yellow colour, and placed on ſpikes beautifully branched.

The fruit is of that kind called a drupa, and is ripe towards the end of May. It is of an oval ſhape, is black, ſmooth and ſhining. The pulp is fleſhy and ſoft; the taſte a nauſeous ſweet. The nut is flattened, and on one ſide winged. The kernel is ſmall, flat, and taſtes ſweet.

The natural number of these drupæ is five on each common receptacle; but, for the most part, there are only two or three; the rest abort by various accidents.

The roots are thick, and run superficially under the surface of the ground to a considerable distance. The bark is rough, scaly and warted. The inside when fresh is a full yellow, but when dry paler. It has but little smell. The taste is bitter, but not very disagreeable. This is the true *Cortex Simarubæ* of the shops.

This tree is known in Jamaica by the names of Mountain Damson, Bitter Damson and Stave-wood. The shops are supplied with this bark from Guiana; but now we may have it from our own islands at a moderate expence.

On examining the fructification, I found this tree to be a species of Quassia. Under that name, I sent it to Europe, and Linnæus adopted it into his system.

There are male flowers on one tree, and female flowers on another; and this is invariably the case in Jamaica.

Sensible Qualities of Cortex Simarubæ.

I can discover no astringency in the cortex simarubæ, either by the taste, or by the various tests to which I subjected it. Nor is there any mucilaginous quality to be perceived in the recent bark, or in the decoction of that which has been dried.

Its Medical Virtues in general.

Most authors who have written on the simaruba, agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motions, promotes the secretions by urine and perspiration, removes that lowness of spirits attending dysenteries, and disposes the patient to sleep; the gripes and tenesmus are taken off, and the stools are changed to their natural colour and

and confiftence. In a moderate doze, it occafions no difturbance or uneafinefs; but in large dozes it produces ficknefs at ftomach, and vomiting. Negroes are lefs affected by it than white people.

Preparation of Simaruba Bark.

THE fimaruba bark yields its qualities to water, either in cold infufion or in decoction. I prefer the latter. Phyficians have prefcribed the bark in different quantities; but it feems now agreed that the following proportion is the beft:

Two drams fimaruba bark, boiled from twenty-four ounces of water to twelve ounces, then ftrained.

THIS is divided into three equal parts, and the whole taken in twenty-four hours.

WHEN the ftomach is reconciled to it, three drams may be boiled in the fame quantity of water, and taken as above mentioned. Some join aromatics to the decoction of this bark; others give a few drops of laudanum with each doze. The decoction is to be drank daily till the diforder is cured, which fometimes happens in a few days, and at other times it may require weeks to perfect a cure.

Of the Effects of Simaruba in particular Difeafes.

HAVING thus treated of the fimaruba in general, I am now to mention its ufe and effects more particularly in different difeafes, and firft in the Dyfentery. In the years 1718 and 1723, an epidemic flux prevailed in France, and fwept off a great number of people of all ages and of both fexes. This diforder not only refifted all the medicines given, but was aggravated by fmall dozes of ipecacuanha, the mildeft purgatives, and all aftringents. The diforder was happily cured by the fimaruba.

M. Jussieu ufed this bark for fifteen years in obftinate dyfenteries with great fuccefs; and continued its exhibition, although the catamenia in women, or hæmorrhage from piles in men, occurred during the cure.

Modern phyficians have found from experience, that this medicine is only fuccefsful in the third ftage of dyfentery, where there is no fever, where too the ftomach is no way hurt, and where the gripes and tenefmus are only continued by a weaknefs of the bowels. In fuch cafes, Dr D. Monro gave two or three ounces of the decoction every five or fix hours, with four or five drops of laudanum; and found it a very ufeful remedy.

The late Sir John Pringle, Dr Huck Saunders, and many others, prefcribed the cortex fimaruba in old and obftinate dyfenteries and diarrhœas, efpecially thofe brought from warm climates. Fluxes of this fort, which were brought home from the fieges of Martinico and the Havannah, were completely and fpeedily cured by this bark. The urine which, in thofe cafes, had been high coloured and fcanty, was now voided in great abundance, and perfpiration reftored. Dr James Lind at Haflar Hofpital, fays, That the fimaruba produced thefe effects fooner, and more certainly, when given in fuch quantity as to naufeate the ftomach. Dr Huck Saunders remarks, That if the fimaruba did not give relief in three days, he expected little benefit from its farther ufe; but others have found it efficacious in fluxes, after a continued ufe for feveral weeks. Authors have cautioned us againft the ufe of this bark where the inteftines are ulcerated and difpofed to cancer after fluxes.

In diarrhœas, from abforption of pus, the fimaruba has given relief; the former difcharge from fuch ulcers was reftored, and the pus meliorated.

Lienteria itfelf, and even hepatic fluxes, have been cured by the fimaruba, after other medicines were tried without fuccefs. *Vide* Act. Natur. curiof. tom. ii. p. 80,—82.

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In putrid fevers, (as we are told) attended with coldneſs of the extremities, colliquative ſweats and ſtools, and great dejection of ſpirits, this bark performed wonders, and many recovered by its uſe. *Vide* Roupe de Morbis Navigantium, p. 311.

Habitual colics, with bloody ſtools, attended with fever and delirium, have been radically cured by the ſimaruba bark.

Immoderate fluxes of the menſes and from piles, have been happily ſtopped by this medicine; and it would appear from ſome late trials, that fluor albus has been remedied by the ſame bark.

De Haen found the ſimaruba to be an excellent vermifuge; and uſed it with ſucceſs in diſeaſes depending on worms, particularly fluzes.

My own experience, and that of many living friends, are convincing proofs to me of the efficacy of this medicine; and I hope the ſimaruba bark will ſoon be in more general uſe.

QUASSIA SIMARUBA.

Flos Masculus.

Cal. Perianthium monophyllum, parvum, quinquefidum, denticulis ovatis, erectis.

Cor. Petala quinque, feffilia, æqualia, lanceolata, fubrevoluta, calyce triplo longiora, calyci inferta. *Nectarium* ex fquamis decem, ovatis, villofis, bafi filamentorum interiori infertis.

Stam. Filamenta decem, filiformia, æqualia, longitudine corollæ. *Antheræ* oblongæ, incumbentes; in centro floris corpus carnofum, orbiculatum, decem-fulcatum.

Piſtillum nullum.

Flos Femineus.

Calyx et *Corolla*, ut in flore mafculo.

Piſtillum. Germina quinque fubrotunda, introrfum coalita. *Stylus* cylindraceus, erectus, quinque-partitus, longitudine corollæ. *Stigmata* fubulata, recurvata, perfiftentia.

Pericarpium. Drupæ quinque laterales, diftantes, receptaculo orbiculato, carnofo infertæ.

Semina. Nux oblongo-ovata, acuminata, unilocularis. *Nucleus* compreffus.

Inflorescentia.

Panicula compofita. Pedicellis fubjicitur ftipula lanceolata, petiolata. Folia alternato-pinnata. Foliola oblonga, obtufa, nitida, integra, bafi attenuata, fubfeffilia; coftis lateralibus nervofis.

E X-

EXPLANATION OF THE PLATES.

PLATE I.

QUASSIA SIMARUBA MAS.

1. A flower of its natural ſize.
2. The ſame magnified.
3. The calix of the natural ſize.
4. The ſame magnified.
5. The corolla.
6. The ten ſtamina.
7. Two ſtamina, the inſide of one, the outſide of another, preſented to view.
8. The fleſhy maſs in the centre of the flower.
9. The ſame magnified, to ſhew in what manner the ten ſtamina and ſquamæ are placed.

PLATE II.

QUASSIA SIMARUBA FEMINEA.

1. 2. 3. 4. The ſame as in the male flowers.
5. The piſtillum.
6. The ſtyle.
7. The ten imbricated ſquamæ.
8. One pericarpium or drupa.
9. The horizontal ſection of the ſame.
10. The nut.
11. A perpendicular ſection of the ſame.
12. The nucleus or kernel.


Quassia Sima

Simaruba feminea


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John Miller del^t.


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I.Beuge, Sculp!

Quassia Simarub

rruba mas

John Miller delt

I.Bouge Sculp.t

XI. *On the* MOTION *of* LIGHT, *as affected by refracting and reflecting Substances, which are also in Motion. By* JOHN ROBISON, M. A. F. R. S. EDIN. *and Professor of Natural Philosophy in the University of Edinburgh.*

[*Read by Mr* PLAYFAIR, *April* 7. 1788.]

FEW of the mathematicians and philosophers of the present age have acquired a greater or better founded reputation than the celebrated Abbé BOSCOVICH; and there is none from whose writings I have received such variety of instruction and entertainment. His Theory of Natural Philosophy will ever be considered by impartial judges, not only as one of the boldest, but also as one of the most ingenious researches into the secrets of nature. There is hardly a branch of physico-mathematical philosophy which he has not cultivated with success; and in this cultivation he has exhibited the most acute penetration and the greatest address. In all his investigations too he has given the most beautiful specimens of geometrical invention and elegance, and greatly heightens the pleasure of his readers, by marking out distinctly the progress of his own mind in his researches.

Mr BOSCOVICH has lately obliged the public with a collection of several of his smaller works in five volumes quarto, published at Bassano in 1785. In the second and fourth volumes of this collection, are two very curious papers, on what is called the aberration of light, or the effect which is produced on the apparent place of visible objects by the motion of the observer.

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There is one deduction which he makes from his premiſes, extremely curious in itſelf, and having the moſt ſurpriſing conſequences. It is this: If a teleſcope be conſtructed, having its tube filled with water, and be directed to a terreſtrial object properly ſituated, it will be found to deviate from that object by a certain determined quantity every day. It will follow from this, that a perſon ſhut up in a mine or dungeon, may, without ſeeing the ſun or heavens, diſcover the motion of the earth round the centre of the ſolar ſyſtem, and alſo whether this centre be in motion, and the velocity and direction of this motion.

THE contrivance of a teleſcope filled with water, has been long familiar to my thoughts, (as a means of diſcovering whether light be accelerated when refracted towards the perpendicular) in conſequence of the ſpeculations of my ingenious friend Profeſſor WILSON of Glaſgow. But all my attempts to conſtruct ſuch a teleſcope have hitherto proved abortive, for want of a ſubſtance ſufficiently tranſparent to admit of the neceſſary magnifying power. I ſaw that this rendered uſeleſs the beautiful theory of their conſtruction which is contained in this paper of Mr BOSCOVICH. But, at the ſame time, I ſaw that this aberration of terreſtrial objects would enable us to decide the ſame queſtion by means of a compound microſcope of a very eaſy conſtruction. If a cylindrical piece of glaſs be ground ſpherical at one end, and plane at the other, and if the plane ſurface be ſituated a ſmall diſtance beyond the principal focus of the ſpherical ſurface, and a ſcratch be made on the plane ſurface, and conſidered as a viſible object, an image of this ſcratch will be formed in the conjugate focus of the ſpherical ſurface, which image may be viewed by means of a deep eye-glaſs, as in the ordinary compound microſcope. If this image be formed on a frame of wires, like the wires of an aſtronomical teleſcope, there muſt be obſerved the ſame diurnal deviation that Mr BOSCOVICH announces with reſpect to his teleſcope,

ſcope, but in the oppoſite direction; as in the microſcope, there would be no want of light, we ſhould have the moſt ſatisfactory deciſion of this important queſtion in optics, and alſo the opportunity of detecting any hitherto unknown motions of the globe which we inhabit. It may alſo be ſhown, that, if any of theſe motions be very conſiderable, we ſhall determine another very important queſtion in optics, *viz.* Whether the motion of light be affected by the motion of the luminous body.

On theſe, and many other accounts, I was eager to conſtruct this microſcope, and ſet about it accordingly. But I happened at that time to be engaged in that part of my courſe of lectures where I had occaſion to conſider the apparent motions of bodies. I conſider it as the fundamental propoſition on this ſubject, that "*the apparent motion of a body is compounded of its real* "*motion, and the oppoſite to the real motion of the obſerver.*" The conſequence is, that, ſince the motions of the terreſtrial object and of the obſerver are always nearly equal, there ſhould be no apparent motion in the object, and therefore no apparent diurnal change of place. This ſtartled me, and cauſed me to conſider the matter more minutely. Profeſſor Wilson, to whom I communicated my doubts, raiſed other objections, founded on the application of mechanical principles to that hypotheſis, with reſpect to light, which the Abbé Boscovich profeſſes to maintain. In my ſubſequent ſpeculations on this ſubject, I found, that the application of the above mentioned propoſition was not ſtrictly juſt with reſpect to the apparent *place* of the terreſtrial object; but I was led by it to diſcover the real ſtate of the matter, by applying it to the determination of the apparent motion of the *light* by which the object is ſeen. I thus detected the circumſtance which Mr Boscovich had overlooked, and which unfortunately puts an end to the hopes which I had entertained of many curious and important diſcoveries. I flatter myſelf that this Society will not think this ſubject unworthy of their notice; but am extremely ſorry that my infirm ſtate of health

health does not at present permit me to give such an account of it as its importance deserves. I propose, however, to undertake it as soon as I am able. This I am incited to do, not merely on account of the singularity of this particular subject, but more especially because its discussion depends on a more general, and hitherto unconsidered subject in physico-mathematical science, *the motion of light as affected by bodies which are also in motion*. This I have considered some years ago, as far as I thought necessary for my elementary course of lectures, and I then investigated the fundamental proposition which I shall include in this discourse. Perhaps I should offer some apology for troubling the Society with my thoughts on the subject before I have put them into a more perfect form. I shall frankly tell my reasons for this conduct. This paper of Mr BOSCOVICH must excite the attention of philosophers. Other speculations also which have lately been made by ingenious men, will turn the attention to the subject, and enquiries will be instituted, and their results made public. I should not chuse to be thought indebted to the researches of others for the results of my own enquiries, and therefore wish to ascertain my claim to any thing which may be valuable in my speculations, by this present imperfect account of them.

I SHALL therefore lay before the Society a short account of the experiment, as proposed and described by Mr BOSCOVICH, and of the result which he expects from it, and some of the most remarkable consequences which he deduces from this result. I shall, in the next place, point out the oversight which he has made in announcing the result, and state what ought to be the result, on the physical principles adopted by him; principles which will be overturned if the result of the experiment should be what he expects, but established if it should be what I assert. In the last place, I shall give the fundamental proposition for determining the reflection and refraction of light by

by moving furfaces, and briefly mention fome of the moft ufeful corollaries.

Let O, (fig. 1.) be a terreftrial object, whofe pofition is to be determined by an obferver placed at B′, and furnifhed with a common furveyor's theodolite. He muft place the index of his inftrument fo that the light coming from the object in the direction OB′, may pafs through the two holes A′, B′, which conftitute the plane fights of his theodolite; that is, the three points O, A′, B′, muft be in a ftraight line. The inftrument is fo conftructed that the ftraight line paffing through the holes A′, B′, is parallel to a line NS drawn along the ruler or index upon which the fights are placed, and the divifion upon the arch, which is cut by the line NS, indicates the pofition of the object.

But now let us fuppofe that, by the motion of the earth, the obferver is uniformly carried along the ftraight line B′β perpendicular to B′O, while, in the mean time, the object is carried with an equal motion along the line Oδ parallel to B′β. It is now evident, that, if the inftrument, without altering its pofition, be carried along in the direction B′β, the light which enters the hole A′, in the direction OA′, will not pafs through the hole B; for, when the light entered the hole A′, the other hole was at B; but when the light arrives at B′, the hole B′ has got to fome place R in the line B′β. Take the point B, fo that the ftraight line Oβ may be to B′β as the velocity of light to the velocity of the earth. Through A′ draw the ftraight line A′Aα, parallel to B′β, cutting the line Oβ in the point A. Draw DAB parallel to OA′B′. Now, let the theodolite move from the fituation A′B′ to the new fituation AB, while the light moves from O to A. It is evident that the light will enter the hole A, and proceed in the direction Aβ. In the mean time, the hole B will have moved from B to β; for Aβ is to Bβ, as Oβ is to Bβ, that is, as the velocity of light to the velocity of the theodolite.

dolite. Therefore an eye placed behind the hole B will receive the light which paſſes through it when in the ſituation β, and the obſerver will ſee the object through the ſights of the inſtrument. He will ſee it by means of light moving in the direction $O\beta$; but he will not imagine that the object lies from him in the direction βO; for he eſtimates the direction of the object by the poſition of the fiducial line of his inſtrument, which is always parallel to the line joining the centres of the holes which are its ſights. When he ſees the object, theſe holes are at β and α, and therefore the obſerver aſſigns to the object the direction $\beta\alpha$. Let BA and $\beta\alpha$ cut the line $O\delta$ in the points D and δ; it is evident, that, when the object is at O, D and δ, the anterior ſight of the theodolite, is at A′, A, and α, and the other ſight is at B′, B and β; therefore, when the object is ſeen through the inſtrument, it is always ſeen in its real place, and in its true direction, although not in the direction of the light by which it is ſeen; conſequently, if the index be directed ſo that the object may be ſeen through it, that is, if the index be pointed to the object in the common way, and the whole inſtrument be kept firm in its poſition, it will *always* point to the object, although both the inſtrument and object are continually changing their places by the motion of the earth round the ſun and round its own axis.

But now let us ſuppoſe, with Mr Boscovich, that the interval between the two ſights is filled with water contained in a tube, and bounded by two plates of glaſs at A and B, perpendicular to the line AB, and covered externally with paper, pierced with two ſmall holes at A and B. Now, ſays Mr Boscovich, the light which enters at A will not be at B when the hole B arrives there; for, if the velocity of light in water be to the velocity of light in air, as the ſine of incidence in air to the ſine of refraction in water, then, while the hole B comes to β, the light will move from A to E, ſo that AE is to $A\beta$ as four to three nearly; conſequently, when the light has come

to

to β, the hole B will have moved over $B\gamma$, which is three-fourths of $B\beta$; therefore an eye, placed behind the hole B, will not ſee the object through the ſights of the inſtrument, but will ſee an object lying to the right hand of it, having its angular diſtance equal to $\gamma A\beta$; or, if the inſtrument, inſtead of having a hole A for the anterior ſight, has two fine wires croſſing each other in A, the object will appear on the oppoſite ſide of their interſection from that towards which the earth is moving.

FROM this reaſoning, Mr BOSCOVICH concludes, that if this inſtrument be placed at the earth's equator on the day of the winter's ſolſtice, and the index be directed to the real place of an object due ſouth of it, the object will not appear at the interſection of the croſs wires of the anterior ſight, but, at noon, will appear 5″ to the eaſt of that interſection, at ſix o'clock in the evening, it will appear 5″ above it; at midnight, it will appear 5″ to the weſtward of it; and at ſix o'clock next morning, it will appear 5″ below it. The object will, therefore, appear to deſcribe a circle round the interſection of the croſs wires in twenty-four hours, the diameter of which will ſubtend an angle of 10″. In other poſitions of the index, and other days of the year, the apparent motion of the object will be different; but it will never appear in its true place, except in thoſe inſtants that the fiducial line of the inſtrument happens to be parallel to the line of the earth's motion at that time.

Mr BOSCOVICH proceeds to ſhow that, if the theodolite has a common aſtronomical teleſcope, inſtead of plane ſights, the appearances will be preciſely ſimilar. If the index be directed to the real place of an object, the object will be ſeen at the interſection of the croſs wires of the eye-piece; and if the inſtrument be firmly fixed in its poſition, the object will always appear at this interſection, notwithſtanding the motion of the earth. But if the teleſcope be filled with water, and be directed to the real place of an object ſituated as above mentioned, on the noon of the winter's ſolſtice, the object will appear 5″ to

the weſt of this interſection, and, in twenty-four hours, will deſcribe round it a circle, whoſe diameter ſubtends an angle of 10″, but in a direction oppoſite to that deſcribed round the interſection of the croſs wires of the plane ſights. The intelligent reader will eaſily ſee that theſe deductions are juſtly made from the premiſes.

Mr BOSCOVICH, in the laſt place, ſhows that if light be retarded in its paſſage from air into water, the appearances with the water teleſcope will be diametrically oppoſite to thoſe above deſcribed, and therefore earneſtly propoſes this experiment to philoſophers, as a mean of deciding that important queſtion in phyſics. I call it an important queſtion; becauſe the acceleration of light in the inverſe proportion of the ſines of incidence and refraction affords an inconteſtible proof that the forces which refract light towards the perpendicular are directed perpendicularly *toward* the refracting ſurface, and nearly demonſtrates that light conſiſts of corpuſcles emitted by the ſhining body. The retardation of light, in the direct proportion of the ſines of incidence and refraction, is totally incompatible with this hypotheſis concerning the nature of light, and, in my opinion, with the hypotheſis of thoſe who maintain that viſion is produced by the undulations of an elaſtic fluid, although it has generally been ſuppoſed to be a conſequence of that hypotheſis.

I HAVE already ſaid that my repeated attempts to conſtruct a water-teleſcope of ſufficient magnifying power have hitherto failed, in conſequence of my not being able to find a fluid ſufficiently tranſparent. Lime-water is the moſt tranſparent fluid that I know; and I have filled with it a teleſcope five feet long. But, when I increaſed its magnifying power to more than thirty times, it was vaſtly too dark, although the aperture was ſo great as to make it very indiſtinct. I am therefore convinced, that although I ſhould employ Mr BOSCOVICH's moſt beautiful and ingenious conſtruction to remove the indiſtinctneſs, there would

would be a great deficiency of light; for a teleſcope of this length, magnifying thirty times, would not render 10″ ſufficiently diſtinguiſhable.

But this aberration of terreſtrial objects, announced by Mr Boscovich, muſt be obſerved in a compound microſcope filled with water, or conſtructed in the manner deſcribed in the beginning of this diſcourſe. In ſuch a microſcope, we can have abundance of light by external illumination, and little will be loſt in its paſſage through the ſhort column of lime-water or glaſs.

The intelligent reader will eaſily ſee that this aberration of an object placed before the microſcope muſt be obſerved even at the bottom of a mine. He will alſo ſee that, if the ſun, with his attending planets, be carried along in any direction, with a velocity much greater than that of the earth in its orbit, another aberration will be obſerved, greater than the former, and diſtinguiſhable from it, although blended with it. Conſequently, we ſhould be able to diſcover, by means of this aberration, ſuch hitherto unknown motion of the ſolar ſyſtem. It will readily be believed, therefore, that I engaged with eagerneſs in preparations for this experiment, and in farther reſearches into its theory, and that I was greatly mortified when I found my hopes of curious diſcovery fruſtrated by the detection of an overſight in Mr Boscovich's reaſoning. This I ſhall now ſubmit to the Society.

Mr Boscovich ſuppoſes, that when the light, moving in the direction OA, enters the water tube at A, it moves on in the direction Aβ, deſcribing AE uniformly, while the hole A moves from A to α. But Mr Boscovich, in the ſame diſcourſe, profeſſes to maintain the opinion advanced by Sir Isaac Newton, *viz.* That light is accelerated in water by forces which act perpendicularly to its ſurface. If this be the caſe, the light entering the water at A, in the oblique direction OA, will be refracted towards the perpendicular, and will move in the direc-

tion $A\epsilon$, cutting the line $\alpha\beta$ in the point ϵ, ſo ſituated that $A\beta$ is to $A\epsilon$ as the velocity of light in air is to its velocity in water. This line $A\epsilon$ will cut the line $B\beta$ in ſome point i. Now, ſince the light moves uniformly along $A\epsilon$, while the hole B moves uniformly along $B\beta$, it follows that they will meet in i, where the light will paſs through the hole, and enter an eye placed behind it. The obſerver, therefore, will ſee the object through the water tube or water teleſcope, having the ſame poſition with the plane ſights or common teleſcope; and if the water teleſcope be directed to the real place of a terreſtrial object, however ſituated, and be firmly fixed in its poſition, the object will always be ſeen on the interſection of the croſs wires, and no aberration will be obſerved in conſequence of the earth's motion.

I MAY here obſerve, that this aberration of terreſtrial objects occurred to Mr BOSCOVICH but very lately, namely, while he was writing for the preſs his Diſſertation on the uſe of the water teleſcope, for deciding the queſtion concerning the acceleration or retardation of light, by means of the aberration of the fixed ſtars. It appears that Mr BOSCOVICH has long had this ingenious thought; for M. DE LA LANDE, in the fourth volume of his Aſtronomy, mentions his having received a letter to that purpoſe from Mr BOSCOVICH in the year 1769. Mr BOSCOVICH, in the firſt volume of his Opuſcula, publiſhed at Baſſano in 1785, mentions his having heard that ſome perſon had publiſhed a diſſertation in the Philoſophical Tranſactions of London upon the ſame ſubject, and ſeems diſpoſed to think, that the author had been indebted to Mr DE LA LANDE's information, which had been publiſhed ſome time before. This alludes to a Diſſertation by our worthy member Mr WILSON, now profeſſor of Aſtronomy at Glaſgow. But this gentleman's ingenuity is too eminent to make him need any information which his candour would not diſpoſe him to avow in the moſt public manner. In the preſent inſtance, he is fortunately pro-

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tected againſt every imputation of plagiariſm, as I ſhall preſently make appear, by returning again to the conſideration of the apparent place of objects viewed through a theodolite.

Suppose that the object O is a fixed ſtar, and that, while a ray of light proceeds from it in the direction O$A\beta$, with a uniform motion, the theodolite moves uniformly from the ſituation A'B' to the ſituation $\alpha\beta$. It is evident, that the light will enter the anterior ſight at A, and paſs through the poſterior ſight at β. An obſerver, therefore, will ſee the ſtar by looking through the theolodite. But he will judge falſely of its place; for he will imagine that it lies in the direction $\beta\delta$, while it is really in the direction βO. The angle O$\beta\delta$ is called the aberration of the ſtar, and the proportion of the velocity of light to the velocity of the earth is ſuch that this angle is about 20″. Let us now ſuppoſe that the water tube is uſed. Then, ſays Mr Boscovich, if the water tube have the ſame poſition with the plane ſights, the ſtar will not be obſerved through it; becauſe, when the hole B has come to β, the light which entered at A has got to E, and when this light has got to β, the hole has got only to γ: Therefore, in order to ſee the ſtar, the water tube muſt have a different poſition, which he thus determines:— Make Bϕ equal to $\beta\gamma$, and draw Aϕ. This will be the proper poſition of the tube. For, while the light which enters at A moves from A to β, the poſterior ſight of the theodolite will have moved from ϕ to β, where it will meet the light, and allow it to paſs through to the eye of the obſerver. If the velocities of light in air and water are as three to four, the angle BAϕ will be about 5″, in the opinion of Mr Boscovich, and the aberration of the ſtar will be about 15″, namely, three-fourths of the aberration diſcovered by the plane ſights. In like manner, when the aberration of the ſtar is obſerved with a teleſcope filled with water, by bringing its image to the interſection of the croſs wires in the eye-piece of the teleſcope, it will

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be three-fourths of the aberration obſerved in the ſame manner with the common teleſcope. This account of the experiment is preciſely the ſame with that given by Mr DE LA LANDE, and alſo with that given by Mr BOSCOVICH in the Diſſertation above mentioned.

IT is eaſy to ſee, that Mr BOSCOVICH has made the ſame overſight here as in the caſe of terreſtrial aberration. For, in the *firſt* place, if the tube has the poſition AB, the light which enters at A, in the direction OA, will not proceed in the direction AE, but be refracted at A, and proceed in the direction A*i*, and will meet with the hole B in the point i. The ſtar will, therefore, be ſeen through the water tube, having the ſame poſition with the plane ſights; and if the aberration be obſerved with a common teleſcope, and a teleſcope filled with water, by bringing the image of the ſtar to the interſection of the croſs wires, it will be the ſame in both. In the next place, if the water tube have the poſition Aφ, which Mr BOSCOVICH propoſes, the light which enters at A will not paſs through the poſterior ſight. For the angle BAβ being 20″, and the angle BAφ being 5″, the angle of incidence will be 15″, and the light will ſtill be refracted towards the perpendicular, making with it an angle ſomewhat greater than 11″.

THUS it appears, that the reſult of this experiment, made in the manner propoſed by Mr BOSCOVICH, will be different from what he announces upon the phyſical principles aſſumed by him. What I have here determined to be the reſult of this experiment, perfectly agrees with Mr WILSON's determination in the Philoſophical Tranſactions, where it is propoſed by him as a proof that light is accelerated by refraction out of air into water, in the inverſe proportion of the ſines of incidence and refraction. Thus, theſe gentlemen differ ſo widely in their opinions, both with reſpect to the reſult of the experiment, and the concluſions drawn from it, that the one cannot be ſuſpected of having borrowed from the other.

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I SHALL juſt add here, that if the aberration of the fixed ſtars, obſerved in Dr BRADLEY's manner, as above deſcribed, be different with the two teleſcopes, as Mr BOSCOVICH expects, or if there be obſerved that aberration of terreſtrial objects which he deſcribes, light *is not accelerated*, while refracted towards the perpendicular, in the inverſe proportion of the ſines of incidence and refraction. But if the two aberrations ſhall be found to be the ſame, and if no terreſtrial aberration ſhall be obſerved, we have a direct proof of the acceleration of light in the above mentioned proportion, and of its refraction being produced by forces acting perpendicularly to the refracting ſurface, and almoſt a demonſtration that light conſiſts of corpuſcles emitted by the ſhining body. There is indeed another way of obſerving the aberration of the fixed ſtars, *viz.* by a micrometer within the eye-piece of the teleſcope. This promiſes a different aberration with the two teleſcopes. But my thoughts on this ſubject are not yet ready for the examination of the Society.

I NOW proceed, in the laſt place, to give the fundamental propoſitions reſpecting the motion of light, as it is affected by refracting or reflecting ſubſtances, which are alſo in motion; propoſitions which will afford an eaſy and ready ſolution of every queſtion which may be propoſed.

THERE are two ways of eſtabliſhing the fundamental doctrines on this ſubject. The firſt and beſt method is to ſtate the leading facts, or to announce the general phyſical laws as matters of obſervation and experience, and then to give a theory of all the ſubordinate phænomena, in the order of their generality, by ſhowing in what manner they are comprehended under the general laws already eſtabliſhed. But, in the preſent caſe, this method cannot be followed. For, in the phænomena which we obſerve, the motion of light is blended with ſeveral motions which we *know* to obtain in the reflecting and refracting ſubſtances which affect it, and perhaps with many other motions

motions of which we are entirely ignorant. For this reaſon, we cannot ſay *what is the abſolute motion of light*, nor aſcertain *from fact* what *changes* it undergoes in its obſerved refractions and reflections. Since, therefore, we cannot ſimplify the phænomena which nature preſents to our view, we cannot eſtabliſh thoſe general laws which would be the foundation of a phyſical theory.

THE only other method which ſeems to remain, is to take up ſuch opinions concerning the nature of light, as ſeem moſt rationally deducible from the phænomena which we obſerve, and then to deduce, by the eſtabliſhed principles of mechanics, ſuch conſequences as ſhould ariſe from the action of refracting and reflecting ſubſtances upon this hypothetical light. We ſhould then ſelect ſuch of theſe conſequences as will admit of a compariſon with obſervation. If theſe conſequences ſhall be found inconſiſtent with obſervation, the hypotheſis concerning the nature of light muſt be rejected, and trial muſt be made of a new one. But if they ſhould be found to agree with obſervation, and at the ſame time be ſufficiently various, we may then admit the hypotheſis to have a degree of probability proportioned to the extent of the compariſon which we have made of its conſequences with obſervation; we may then diſcover by this means parts of a hypotheſis which muſt be admitted as true, although the hypotheſis cannot be demonſtrated in its full extent.

I AM acquainted with two hypotheſis only concerning the mechanical nature of light, which, in the opinions of the learned, ſeem rationally deduced from the phænomena. The firſt is that which is advanced by Sir ISAAC NEWTON, in ſeveral parts of his celebrated writings. He ſays that light may perhaps conſiſt of ſmall particles emitted by the ſhining body with prodigious velocity, which are afterwards acted upon by other bodies, with attracting or repelling forces like gravity, which deflect them from their rectilineal courſes in refractions

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and reflections. He shows, if this be the case, that the combined forces of all the particles of a body which act at once on a particle of light, compose a force whose direction is perpendicular to the surface of the body. When, therefore, these forces tend *toward* the body, the light, at its approach to that body, is *accelerated* and is refracted *toward* the perpendicular to its surface. But when these forces tend *from* the body, the light is *retarded*, refracted *from* the perpendicular, and sometimes *reflected* with its former velocity, and in an angle equal to the angle of incidence. When these consequences are compared with observation, the most complete agreement is found to obtain. Hence Sir ISAAC NEWTON deduces, that when light is *observed* to be refracted toward the perpendicular, it has really been actuated by forces tending toward the refracting body, and that it is accelerated. But when the light is refracted from the perpendicular, it has been actuated by forces tending from the body, and is retarded. Also, when it is reflected on its approach to a body at an angle equal to the angle of incidence, it has been actuated by forces tending from the body, and moves with its former velocity. When these conclusions are combined with the former deductions from the hypothesis, and the result is compared with observation, the most perfect agreement is still discovered! For these reasons, this hypothesis has acquired great credit; and deserves to be examined on the present occasion.

THE other hypothesis is that of Mr HUYGHENS and Dr HOOKE. These gentlemen suppose that, as hearing is produced by means of the tremulous motion of elastic air, which affects the ear, so vision is produced by the tremulous motion of elastic light, which affects the eye. This hypothesis was announced and applied to the explanation of phænomena in very general terms, and did not, for a long while, much engage the attention of the learned. The celebrated mathematician Mr EULER has lately brought it into credit, having made some alterations

in it. He ſuppoſes, that viſion is produced by the tremulous motion of an elaſtic fluid which he calls æther, and which he ſuppoſes to pervade all bodies. He attempts to ſhow that the propagation of this tremulous motion is analogous to the appearances in the reflection and refraction of light. I confeſs that I cannot admit his reaſonings on this ſubject to be agreeable to the principles of mechanics; and I am decidedly of opinion, that the propagation of the tremulous motion of an elaſtic fluid is totally inconſiſtent with thoſe facts in viſion where no refraction or reflection is obſerved. But I ſhall reſerve my objections till another opportunity, when I propoſe to ſubmit to this Society a mechanical examination of this hypotheſis, and I ſhall admit for the preſent that Mr EULER's explanation of refraction and reflection is juſt. It is an eſſential propoſition in this hypothetical theory, that the velocities of the incident and refracted light are proportional to the ſines of incidence and refraction, and therefore that light is retarded when it is refracted toward the perpendicular. It ſeems a neceſſary conſequence that, in this caſe, the particles of æther are actuated by forces tending from the refracting body. I ſhall, therefore, conſider what effects muſt reſult from the combination of this retardation with the motion of the refracting body. If time will allow, I ſhall conſider what will be the effects produced on the motion of light by the motion of the viſible object. Theſe are ſo different in the two hypotheſes, that it is very probable that ſome natural appearance may be found which will give us an opportunity of determining whether either of theſe hypotheſes is to be received as true. Dr ROBERT BLAIR, profeſſor of Aſtronomy in this Univerſity, has pointed out a caſe of this kind, in the rotation of the planet Jupiter round its axis, and has ſuggeſted a method of inveſtigation, exceedingly ingenious, and which ſeems to promiſe ſucceſs. I think that another may be obſerved in the planet Mercury, when in his greateſt elongations from the ſun.

I

I NOW begin with an examination of the Newtonian hypothesis. But I ſhall content myſelf with one conſequence of it only, *viz.* That in refractions and reflections, the light is actuated by forces whoſe direction is perpendicular to the ſurface of the refracting or reflecting body. I ſhall here conſider the effect of ſuch forces only as tend toward the body; becauſe it will be evident that the ſame reaſoning will apply, without any variation, to the effects of forces tending from the medium.

LET XZY (fig. 2.) be a plane ſurface which ſeparates a refracting medium, ſuch as glaſs, from a void, the medium being ſuppoſed to be below the plane XY. Let it be ſuppoſed that ZA, perpendicular to ZY, is the greateſt diſtance at which a particle of the medium acts upon light. Make ZB, on the other ſide of XY, equal ZA, and draw the planes AQ, BS, parallel to XY. While the light is between the planes AQ and BS, it is affected by the refracting forces. For while it is between the planes AQ and XY, it is acted on by all the particles of the medium, whoſe diſtance from it does not exceed ZA; and while it is between the planes XY and DS, there are more particles below it whoſe diſtance does not exceed ZA than there are above it. But when the light is below BS, it is equally acted on in all directions, and its motion through the medium is not affected by the refracting forces.

LET us call the ſpace contained between the planes AQ and BS by the name of the refracting ſtratum; and let us ſuppoſe, at firſt, that the refracting forces act uniformly through the whole extent of the ſtratum.

LET the light, moving in the direction HAF, enter the refracting ſtratum at A, while the medium is moving in the direction AI; and let AF, AI, be the ſpaces which they would uniformly deſcribe during the time that the refracting forces would impel a particle of light, from a ſtate of reſt in A, through AB. Let the velocity which the light would acquire by this acceleration acroſs the refracting ſtratum, be called the

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ſpecific velocity of the medium. It is known that, if it moved uniformly with this velocity, it would deſcribe AO, double of AB, during the time of deſcribing AB with the uniformly accelerated motion. Therefore, (taking this for the unit of time) AF, AI and AO, will expreſs the velocity of the incident light, the progreſſive velocity of the medium, and the ſpecific velocity. It is alſo known, that the light, in paſſing through the refracting ſtratum, will deſcribe a parabola ACL, which AF touches in A, and of which AB is a diameter, having BL, equal and parallel to AF, for an ordinate.

Produce IA till Ai is equal to AI; complete the parallelogram AFfi, and draw the diagonal Af. The motion Af, compounded of AF, the real motion of the incident light, and Ai, the oppoſite to the motion of the medium, is the relative motion of the incident light. This motion will be uniform, becauſe it is compounded of motions which are uniform. Therefore Af will expreſs the relative velocity of the incident light. Draw FL. It is evidently equal and parallel to AB. Let CP be drawn from any point C of the parabola, parallel to AB, cutting AF in P. Complete the parallelograms FLlf, flBA. Draw Cc parallel to Ff, and make Ff : Cc = AF : AP. I ſay that the point c is in a parabola Acl, of which AB is a diameter, and Af a tangent, and which is the relative path of the light, and that L and l, C and c, are contemporaneous places of the light in its real and relative paths. Draw Pp parallel to Ff, cutting Af in p. Draw the ordinate CK, and draw pc, Kc. Then Ff : Pp = AF : AP, = Ll : Cc. But Ff is equal to Ll. Therefore Pp is equal to Cc, and pc is equal and parallel to PC and AK, and Kc is equal and parallel to Ap. Therefore $Kc^2 : Bl^2 = Ap^2 : Af^2, = AP^2 : AF^2, = KC^2 : BL^2, = AK : AB$. Therefore the points A, c, l, are in a parabola, of which AB is a diameter, Af a tangent, and Kc, Bl, are ordinates. Alſo, becauſe Ll : Cc, = Ff : Cc, = AF : AP, = T, AF : T, AP, (by the ſymbol T, AF, &c. is expreſſed the time of moving along AF,

AF, *&c.*) it is evident that Cc is equal and opposite to the motion of the point A, while the light describes the parabolic arch AC, and that Ll is equal and opposite to the motion of A, while the light describes the arch ACL. Therefore L and l, C and c, are contemporaneous places of the real and relative paths of the light, and the parabola Acl is its relative path.

We have seen that Af is the relative motion of the incident light during the time of describing AB by the impulse of the refracting forces acting on a particle of light at rest in A. Let us now suppose that the medium is at rest, and that the light enters the refracting stratum at A, with the velocity and in the direction Af. It must describe a parabola, which Af touches in A, and of which AB is a diameter and Bl an ordinate; that is, it must describe the very parabola Acl, and it must describe it in the same time that the light incident with the velocity, and in the direction AF, describes the parabola ACL. Its motion, therefore, both before and after refraction, is the same with the relative motion of the light having the velocity and direction AF, incident on the medium moving with the velocity and in the direction AI.

Let c be the point of intersection of the parabola Acl and the plane BS. Draw cC parallel to Ai, cutting the parabola ACL in C. C must be the point of that parabola, where the refraction by the moving medium is completed. For Ll : Cc = Af : Ap, = AF : AP, = T, AL : T, AC, = T, Al : T, cC. Therefore, while the light moves from A to c, the point c moves from c to C, where the light will pass through it, and the refraction be completed, the plane BS having now gotten into the situation bs, and the plane AQ into the situation aq.

Draw the ordinates ADE, Ade, to the diameters PC, pc, and draw mr, the directrix of the parabola Acl, and join Dd. It is known that AF is to AE as the velocity in A to the velocity in C. Now, AE : AD = AF : AP, = Af : Ap, = Ae : Ad. Therefore, Dd is parallel to Cc. Therefore the velocity Ae,

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compounded of AE and Ee, which is equal and oppoſite to AI, is the relative velocity of the light in C, and Af, Ae, are the relative velocities of the incident and refracted light. Now, $Kc^2 = AK \times 4\,Am$ and $Ad^2 = cd \times 4cr, = AK \times 4cr$. Therefore, $Ad^2 - Kc^2 = AK \times \overline{4cr - 4Am}, = AK \times 4AB$. Now, $Ad^2 : Ae^2 = Ap^2 : Af^2, = Kc^2 : Bl^2, = AK : AB$. Therefore, $Ae^2 - Af^2 = AB \times 4AB, = AO^2$. That is, when the light has paſſed through, and emerges from the refracting ſtratum, the difference between the ſquares of the initial and final relative velocities is equal to the ſquare of the ſpecific velocity of the medium.

Also, (becauſe $Qe^2 - Qf^2 = Ae^2 - Af^2$) the difference between the ſquares of the initial and final relative perpendicular velocities, is equal to the ſquare of the ſpecific velocity.

But it will not always happen that the light will emerge from the refracting ſtratum after paſſing over it, and it may frequently happen that it will not paſs over the whole extent of it.

Thus, ſuppoſe the light to be within the medium, moving towards the refracting ſtratum, while the medium is moving more ſlowly towards the ſame quarter, or moving towards the oppoſite quarter; and let the relative perpendicular velocity of the light be equal to the ſpecific velocity. Suppoſe that the light paſſes through the refracting ſtratum at A (fig. 3.) moving in the direction and with the velocity AF. It would deſcribe (by the action of the refracting forces) the parabola ALC, of which AB′, equal to AB, is the abſciſſa from a diameter, and B′L, equal and parallel to AF, is an ordinate. Draw In parallel to AQ, cutting FL in n. It is plain that dn is the perpendicular velocity of the medium, dF the perpendicular velocity of the incident light, and nF its relative perpendicular velocity. This is equal to twice AB by ſuppoſition. But FL is equal to AB; therefore Ln is alſo equal to AB, and An is an ordinate to FL. Alſo, LB, drawn from L to B, is a tangent at L, and bLs is the ſituation of the plane BS, when the light which

which entered the refracting ſtratum at A is at L. BL is the velocity with which the light paſſes through L, and Bb is its perpendicular velocity. This is evidently equal to d n, the perpendicular velocity of the medium. Since, therefore, they have the ſame velocity in the direction LF, it is plain, that the light will not paſs through the plane bL ; and becauſe it is ſubjected to the action of the refracting forces, it will be deflected towards AQ, and will deſcribe another arch LC of the parabola, and will be met in C by the point c of the plane AQ, which has moved in the mean time through c C parallel to lL. The point l is the vertex of the relative path A l c, and the abſciſſa l g being equal to BA, it is evident that f g, the relative perpendicular velocity, is equal to twice BA, that is, to the ſpecific velocity.

If, as in fig. 4. the relative perpendicular velocity of the light be leſs than the ſpecific velocity, it will not paſs through the whole refracting ſtratum: For draw l n parallel to AQ, cutting FL in n. It is plain than d n is the perpendicular velocity of the medium, and d F the perpendicular velocity of the light, and n F the relative perpendicular velocity. Becauſe this is ſuppoſed leſs than twice AB, Ln is leſs than FL, and A n is not an ordinate to FL. Let o V h, parallel to A n, touch the parabola in V, and draw h k perpendicular to AB. Then oK, or n d, is the perpendicular velocity of the light. Therefore, ſince the perpendicular velocities of the light in V, and of the medium, are equal, the light is then the neareſt poſſible to the plane BS, which has now obtained the ſituation b s. It is therefore in the vertex of the relative parabola, or, drawing Vv parallel to F f, v will be the vertex of the relative path Av l ; therefore the light, after paſſing through V and L, will deſcribe another arch LC of its parabolic path, and it will be met in C by the point c of the plane AQ, which has in the mean time moved along c C. Fig. 5. exhibits the ſame particulars in the caſe when the light within the medium is moving *from* the refracting ſtratum, but is overtaken by it.

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THUS we ſee that when the light within the refracting medium either meets or overtakes the refracting ſtratum, or is overtaken by it, and the relative perpendicular velocity is not greater than the ſpecific velocity, the light does not emerge from the medium, but is reflected back into it.

IT is farther to be obſerved, that in theſe caſes, the angle of relative reflection is equal to the angle of relative incidence, and the *relative* velocity of the light after reflection is the ſame as before reflection. For the tangents At, tc, (fig. 3. 4. 5.) are equally inclined to the axis of the parabola Alc, and equal portions of them will be intercepted by the diameters AB, FL, and theſe portions expreſs the relative velocities of the light in A and c. Alſo, the relative perpendicular velocity of the reflected light is equal to the relative perpendicular velocity of the incident light, but in the oppoſite direction.

LET us ſuppoſe, that the refracting ſtratum is divided into ſeveral partial ſtrata, by planes parallel to AQ and BS, and that the forces are different in each ſtratum, but uniform through its whole extent.

THE relative motion of the light, emerging from the poſterior ſurface of the firſt partial ſtratum, is the relative motion of the light immerging into the ſecond ſtratum. Therefore, by the preceding reaſoning, the relative motion of the light emerging from the poſterior ſurface of the ſecond ſtratum, is the ſame as if the medium had been at reſt, and the light had approached it with the ſame relative initial motion. The ſame muſt be affirmed of all the partial ſtrata in ſucceſſion, and is therefore true with reſpect to the final motion of the refracted light.

FURTHER, the whole change which is made on the ſquare of the relative velocity of the incident light, in thoſe caſes where it paſſes through and emerges from the refracting ſtratum, is equal to the ſquare of the velocity which a particle of light would acquire if impelled by the variable refracting forces from a ſtate of reſt through the whole refracting ſtratum.

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For if the medium were at reſt, and the light approached it with the ſame relative motion, we have ſeen that the *abſolute* velocity with which the light enters any one of the partial ſtrata, is the ſame with the relative velocity with which it enters it when the medium is in motion. Now, when the medium is at reſt, the change made in the ſquare of the abſolute velocity (whatever this velocity be) is equal to the ſquare of the ſpecific velocity of that ſtratum. Therefore, if the velocity with which the light enters this ſtratum be that which it would have acquired if impelled by the refracting forces from a ſtate of reſt at A, in the anterior ſurface of the firſt ſtratum, the change made on the ſquare of this velocity would have been ſtill the ſame, and the whole velocity would be that acquired by the varied impulſe from a ſtate of reſt in A. This is true with reſpect to the laſt ſtratum; and therefore if the light enter the refracting ſtratum of the quieſcent medium with any velocity, and in any direction whatever, the change made in the ſquare of its velocity, when it has paſſed through all the partial ſtrata, and emerged from the laſt of them, is equal to the ſum of the ſquares of their reſpective ſpecific velocities, and this ſum is equal to the ſquare of what may be called the ſpecific velocity of the whole refracting ſtratum. Now, the abſolute velocity with which the light emerges from the refracting ſtratum of the quieſcent medium is the ſame with the relative velocity with which it emerges from the refracting ſtratum of the medium in motion. Therefore, the change made on the ſquare of the relative velocity of the incident light is equal to the ſquare of the ſpecific velocity of the medium.

We need not employ any time to ſhow that this is alſo true with reſpect to the relative perpendicular velocity. Nor will it be neceſſary to ſhow that when the light, moving within the medium, meets with or overtakes the refracting ſtratum, or is overtaken by it, and the relative perpendicular velocity of the

 incident

incident light is not greater than the ſpecific velocity of the medium, it will not emerge from the refracting ſtratum, but will be reflected back again in the medium; nor to ſhow that the angle of reflection is equal to the angle of incidence, and that the relative velocity of the reflected light is equal to that of the incident light, and that the relative perpendicular velocity of the reflected light is equal to that of the incident light, but in the oppoſite direction.

Laſtly, Let the number of the partial ſtrata be augmented, and their thickneſs diminiſhed, without end. The foregoing demonſtration will now be applicable to the motion of light through refracting ſubſtances which are in motion, and which act on it with forces, *continually* varying according to any law of the diſtances; and it may be received as the fundamental propoſition on this ſubject, that,

If a ray of light, moving in any direction and with any velocity, meet with the ſurface of a refracting medium, which is in motion, its final relative motion will be the ſame as if the medium had been at reſt, and the light had approached it with the ſame initial relative motion.

It is eaſy to ſee that what has been ſaid about the motion of light within a medium which acts upon it with attractive forces, will apply to the motion of light which is without a medium that acts upon it with repelling forces. In ſuch a caſe, the light will not be refracted into the medium, unleſs its perpendicular relative velocity be greater than the ſpecific velocity of the medium, but will be reflected with an equal relative velocity, and at an equal relative angle on the other ſide of the perpendicular.

It is alſo eaſy to ſee that the foregoing demonſtration will apply to the motion of light through two contiguous mediums. For there will be a refracting ſtratum, where the light will be affected by the ſum or the difference of the refracting

refracting forces, according as they act in the same or opposite directions *.

I

* It was about the beginning of 1784 that I investigated the foregoing demonstration, which, as the reader will see, is conducted after the method adopted by Sir ISAAC NEWTON, in his demonstration of the 94th proposition of the first book of the Principia. I applied to my much esteemed colleague Mr Professor PLAYFAIR, for his assistance in a case to which the foregoing demonstration may perhaps be thought not to extend, namely, when the motion of the light, and that of the medium, are perpendicular to the refracting surface. Before I had obtained a demonstration which pleased me, he favoured me with the following elegant analytical demonstration.

LET v be the velocity of a particle of light when it has arrived at the distance x within the refracting medium (x being counted from the point in which the particle began to be acted on, and being less than the distance from that point at which the motion of the particle again becomes uniform.) Let f be the force acting on the particle at the distance x. Let a be the velocity of the incident light, and c the velocity of the medium in the opposite direction.

IT is evident that the force f does not act on the particle during its passage through the whole space $\dot{x}$, but only during its passage through the part $\frac{v}{v+c}\dot{x}$. Therefore, $v^2 = a^2 + 2\int\frac{fv\dot{x}}{v+c}$, and $2v\dot{v} = \frac{2vf\dot{x}}{v+c}$, or $2\dot{v} = \frac{2f\dot{x}}{v+c}$. That is, $2v\dot{v} + 2c\dot{v} = 2f\dot{x}$, and, taking the fluent, $v^2 + 2cv = 2\int f\dot{x} + C^2$. But when $2\int f\dot{x} = 0$, we have $v^2 + 2cv = a^2 + 2ac$, and therefore $v^2 + 2cv = a^2 + 2ac + 2\int f\dot{x}$. Let the fluent of $2f\dot{x}$ (assumed, so that x shall be the distance at which the velocity of the light again becomes uniform) be supposed $= g^2$. Then $v^2 + 2cv = a^2 + 2ac + g^2$. Add c^2 to both sides of the equation. Then $v^2 + 2vc + c^2 = a^2 + 2ac + c^2 + g^2$; and therefore $\overline{v+c}^2 = \overline{a+c}^2 + g^2$. But $a+c$ is the relative velocity of the incident light, and $v+c$ is the relative velocity of the refracted or accelerated light. Therefore the square of the latter exceeds the square of the former by the constant quantity g^2. Now, $g^2 = 2\int f\dot{x}$; and is therefore (by the celebrated 39th proposition of the first book of the Principia) the square of the velocity which a particle of light would acquire if impelled from a state of rest through the whole distance at which the medium acts on light.

SINCE

I NOW proceed to deduce ſome of the moſt uſeful corollaries from the general propoſition.

Corollary 1. THE relative velocities of the incident and refracted light are directly as the co-ſecants, or inverſely as the ſines of the relative angles of incidence and refraction. For it was demonſtrated, that Af and Ae (fig. 2.) are in the proportion of the velocities of the light in the points A and c of its relative path. Now, if ef cuts the plane AQ in the point Q, and AQ be conſidered as the radius, Af and Ae are the co-ſecants of the angles BAf and BAe, which are the relative angles of incidence and refraction. Alſo, Af is to Ae as the ſine of the angle AeQ to the ſine of the angle AfQ, that is, as the ſine of the angle BAe to the ſine of the angle BAf, that is, as the ſine of the relative angle of refraction to the ſine of the relative angle of incidence.

Cor. 2. IF the relative velocity of the incident light be the ſame in all the relative angles of incidence, the relative velocities of the refracted light will alſo be equal in all the relative angles of refraction. For the ſum or the difference of the ſquare of the relative velocity of the incident light, (which is a conſtant quantity) and the ſquare of the conſtant ſpecific velocity, conſtitute a ſurface which is alſo conſtant, and which is equal to the

SINCE the relative velocities, eſtimated in a direction parallel to the refracting ſurface, are not changed by the action of the refracting forces, it evidently follows from this demonſtration that the difference between the ſquares of the relative velocities of the incident and refracted light, is equal to the ſquare of the ſpecific velocity of the medium, whatever may be the directions of the incident and refracted light, and therefore, that the final relative motion of the refracted light is the ſame as if the medium had been at reſt, and the light had approached it with the ſame relative motion. But although this demonſtration would have been much more elegant, and more agreeable to the manner in which I have been accuſtomed to explain the refraction of light, I choſe to retain the demonſtration which I have given in the text, becauſe I think that it gives me a better opportunity of exhibiting to the mind the whole motion of the light during its refraction or reflection. At the ſame time, I thought it my duty to communicate, with Mr PLAYFAIR's permiſſion, his demonſtration to the public.

the ſquare of the relative velocity of the refracted light. This is therefore a conſtant quantity, or the relative velocity of the refracted light is the ſame in all the relative angles of refraction.

Cor. 3. If the relative velocities of the incident light be the ſame in all angles of incidence, the ſines of relative incidence and refraction are in a conſtant ratio, namely, the inverſe ratio of the relative velocities of the incident and refracted light. This appears by combining the laſt corollary with the firſt.

Cor. 4. When light moving with the ſame velocity in all directions, is refracted by a medium at reſt, the ſines of incidence and refraction are in the conſtant ratio of the velocities of the refracted and incident light. This appears from the laſt corollary.

Cor. 5. If the light moving in a medium A be refracted by a medium B, which is in motion, and emerge from it into the medium A, it will regain the relative velocity which it formerly had when in this medium. For the ſquare of its relative velocity while in the medium B, differs from the ſquare of each of its relative velocities in the medium A by the ſame quantity, *viz.* by the ſquare of the ſpecific velocity of the medium B. It is evident that the ſame thing will happen when the light paſſes through ſeveral contiguous mediums in motion before it emerges again into the medium A.

Cor. 6. If the relative paths of the light before its entering into the medium B, and after its emergence from it, be equally inclined to the direction of the medium, the abſolute velocities of the incident and emergent light will be equal, but in no other caſe. This is eaſily ſeen by reſolving the relative motions of the incident and emergent light. Hence we learn, that if the plane ſurface of a plano-convex lenſe be turned towards a fixed ſtar to which the earth is approaching, or from which it is receding, the abſolute velocity of the lateral emergent rays will be increaſed or diminiſhed.

Cor.

Cor. 7. When the light is reflected, the relative angles of incidence and reflection are equal, as alſo the relative velocities of the incident and reflected light.

Cor. 8. But the abſolute angles of incidence and reflection, and alſo the abſolute velocities of the incident and reflected light, are unequal, except in the caſe where the motion of the reflecting ſubſtance is in the direction of the reflecting plane.

If the plane be moving towards that ſide from which the light comes, the angle of reflection will be leſs than that of incidence, and the perpendicular velocity of the reflected light will exceed that of the incident light by twice the perpendicular velocity of the reflecting plane. The contrary will happen if the plane be moving towards the oppoſite ſide.

The application of the foregoing propoſition to Mr Boscovich's experiment is extremely ſimple. When the teleſcope is ſo directed that the image of the object is formed upon the interſection of the croſs wires in the eye-piece, the relative motion of the light is performed along the axis of the teleſcope; or the axis of the teleſcope is in the direction of the relative motion of the light, and indicates the apparent poſition of the object. Now, when the water teleſcope has the poſition AB, (fig. 1.) the relative motion of the light in the teleſcope is the ſame as if the teleſcope had been at reſt, and the light had approached it with the ſame relative motion. Now, the motion DA is evidently the relative motion of the incident light. For it is compoſed of OA, the real motion of the light, and DO, the oppoſite to the real motion of the teleſcope. Now, if the teleſcope had been at reſt, and the light had entered it in the direction and with the velocity DA, it would have proceeded in the direction AB, and therefore the teleſcope muſt always be directed to the real contemporaneous place of the terreſtrial object, and there will be none of that diurnal deviation which Mr Boscovich aſſerts.

Thus

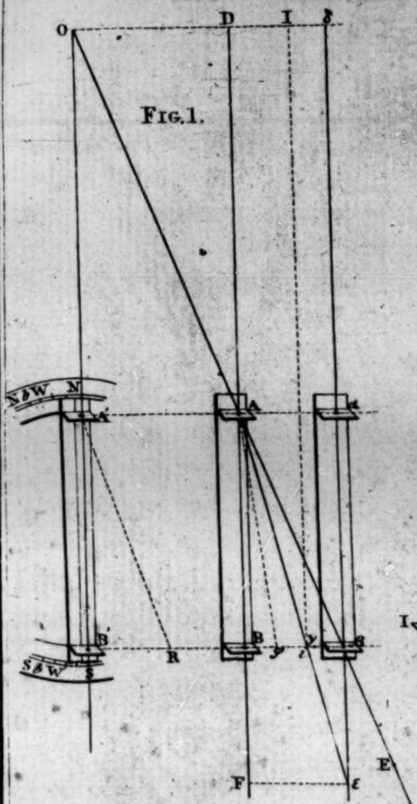


FIG. 1.

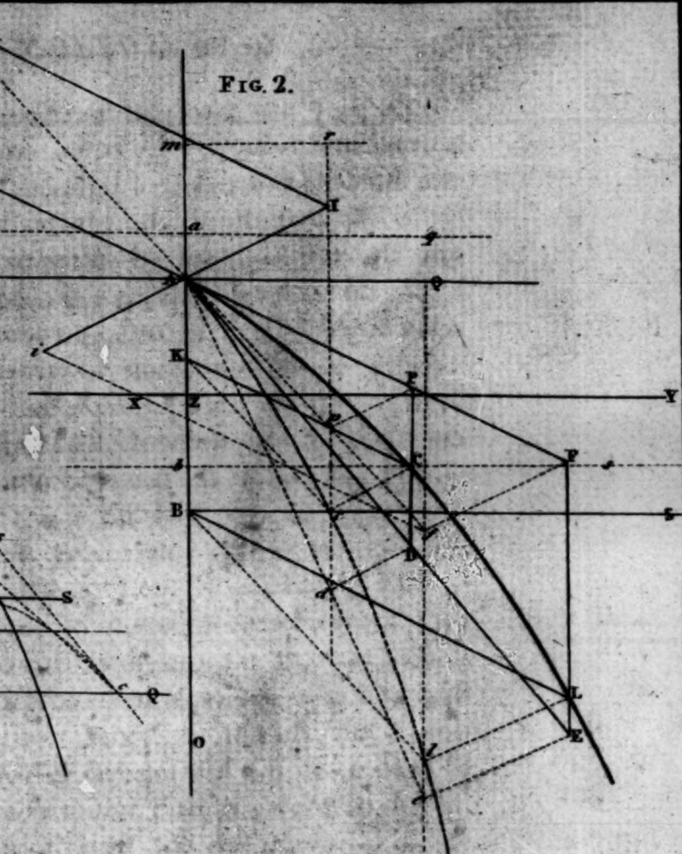


FIG. 2.

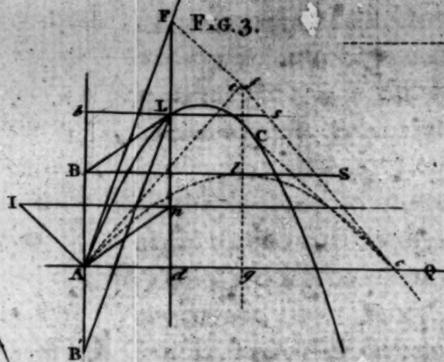
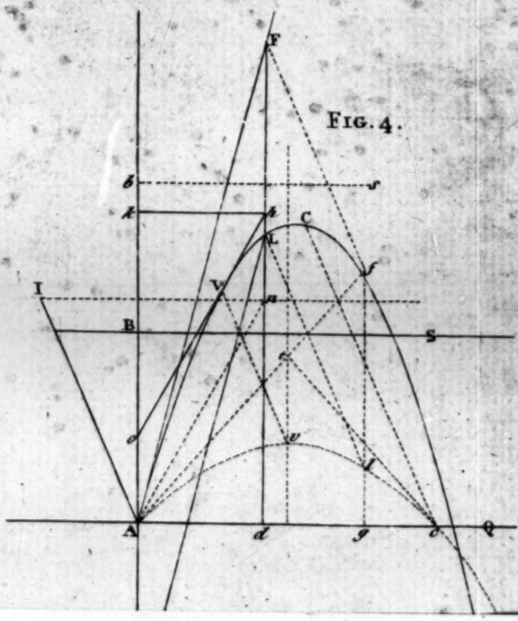


FIG. 3.



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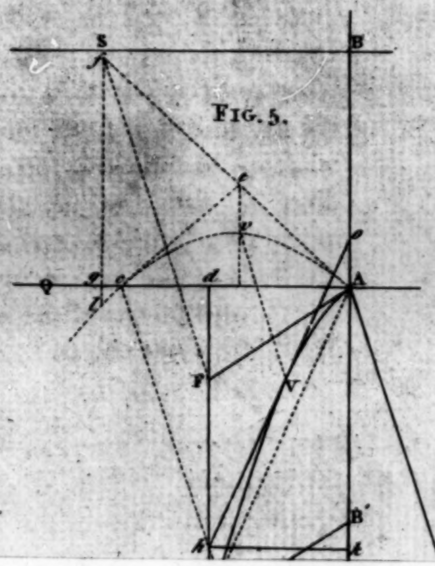

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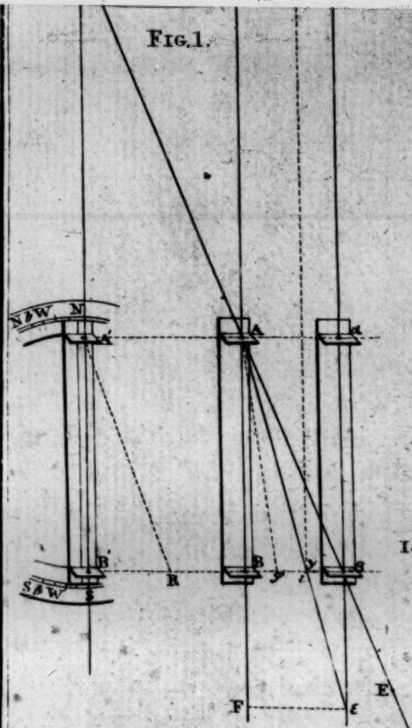
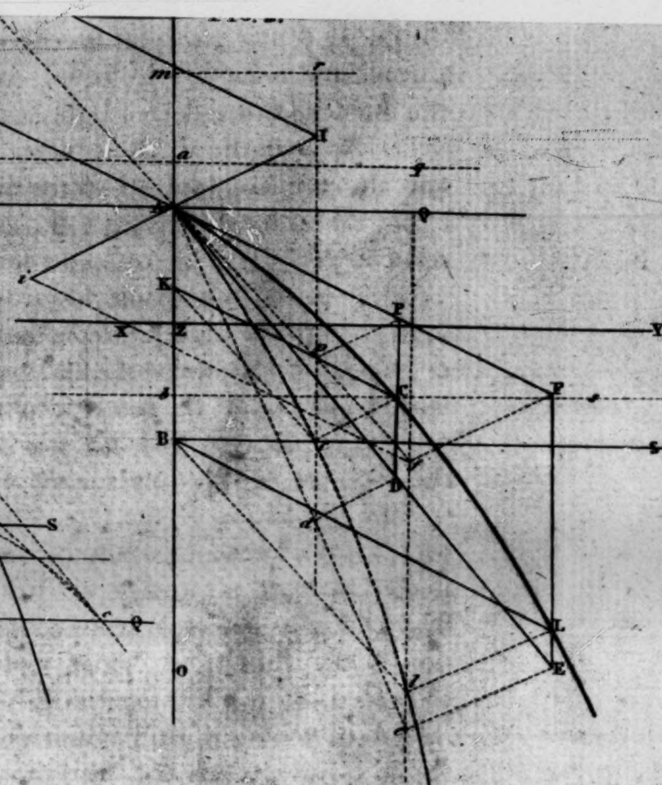


FIG. 1.



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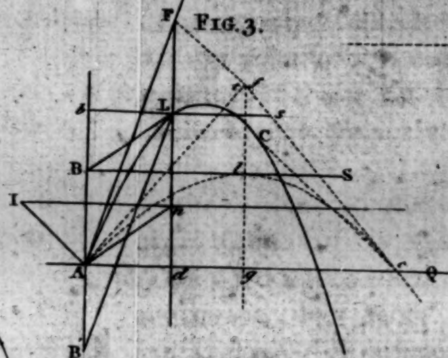

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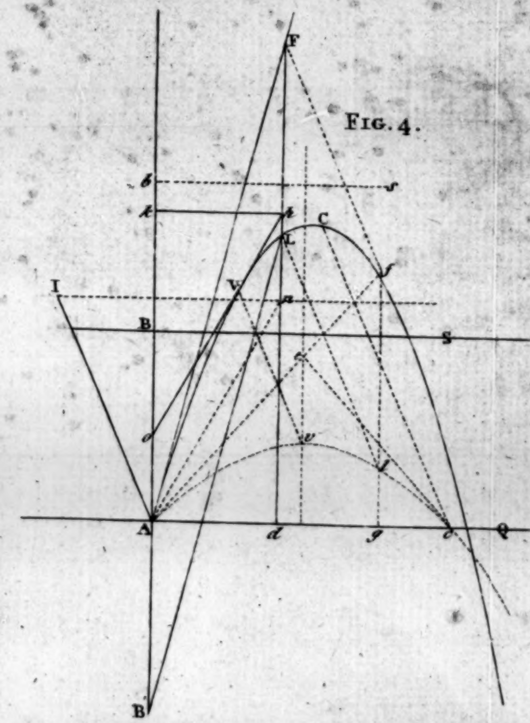

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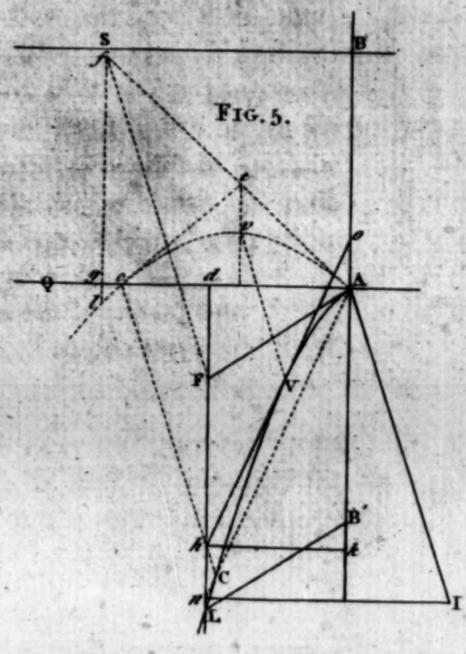

FIG. 5.

Thus it appears that the [illegible]

[illegible] directed to the [illegible]

It will [illegible] appear, that when [illegible]

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[illegible] it appears that [illegible]

[illegible] and the [illegible]

[illegible] with [illegible]

[illegible]

THUS it appears that the water telescope must have the same position with the common telescope, or that both of them must always be directed to the real place of the terrestrial object.

IT will also easily appear, that when the image of a fixed star is formed upon the intersection of the cross wires in the eye-pieces of a common telescope, and a telescope filled with water, the two telescopes will have the same position, and will indicate the same aberration of the fixed stars. For, by the same reasoning, it appears that the water telescope at A must have the position AB, and the aberration OAD is the same with that observed with a common telescope.

WITH this application of the general proposition I shall conclude this paper, reserving a farther account of the subject for another opportunity, if the Society shall think it worthy of their attention.

XII.

XII. DEMONSTRATIONS *of some of Dr* MATTHEW STEWART's GENERAL THEOREMS. *By* ROBERT SMALL, D. D. F. R. S. EDIN.

[*Read by the Author, Feb.* 7. 1785.]

THAT excellent Geometer the late Dr MATTHEW STEWART, as long ago as the year 1746, publiſhed his book of General Theorems, all of them, except the firſt five, without the demonſtrations. As I do not find that any demonſtration of them has ever been made public, I may perhaps flatter myſelf that what I now communicate to this Society will not be wholly unacceptable. The demonſtrations given are of the propoſitions relating to the ſums of the ſquares, and of the fourth powers of lines drawn in a certain manner, and are ſelected from the reſt, as moſt connected with one another. The theorems that reſpect the cubes and other higher powers, may afford materials for another paper, ſhould this meet with the approbation of the Society.

A FEW lemmas and corollaries have been introduced that are not among Dr STEWART's Theorems, and which are therefore diſtinguiſhed by aſteriſks. The references are to the edition of thoſe Theorems publiſhed at Edinburgh, 1746, and the propoſitions are numbered as in that edition, beginning with the ſixth Theorem.

THE-

THEOREM VI. Fig. I.

Let there be any number, m, of given points A, B, C, &c. *a point* X *may be found, such, that if from* A, B, C, &c. *there be drawn straight lines to any point* D, *and to the point* X *found, and if* DX *be joined,*

$$AD^2+BD^2+CD^2 \text{ \&c.} = AX^2+BX^2+CX^2 \text{ \&c.} +mDX^2.$$

Let m be $= 3$.

Suppose the point X found, join DX, from the given points A, B, C draw AE, BF, CG perpendicular to DX, and join AX, BX, CX.

Since $AD^2+BD^2+CD^2 = AX^2+BX^2+CX^2+3DX^2$, and

$AD^2 = AX^2+DX^2-2DX.XE$, and

$BD^2 = BX^2+DX^2+2DX.XF$, and

$CD^2 = CX^2+DX^2+2DX.XG$, the point X in the line DX must be so taken, that the part EX, intercepted between it and AE the perpendicular from the point A, be equal to FX and GX, the sum of the parts intercepted between it and the perpendiculars BF and CG, from B and C; and the parts FX, GX must be in the opposite direction to EX.

This will be effected by the following construction:

Join AB, and bisect it in H; and join HC, and divide it in X, so that $CX = 2HX$; X will be the point required.

From H draw to DX the perpendicular HK.

Since $AH = BH$, we shall have $EK = FK$; and since $CX = 2HX$, we shall also have $GX = 2KX$. Therefore since

$FX = FK-KX$, and

$GX = 2KX$

$FX+GX = FK+KX = EK+KX = EX$, and

$-2DX.XE+2DX.XF+2DX.XG = 0$.

The point X thus found is the centre of gravity of the three points A, B, C. This proposition, and that which follows, are well known, and are given here only for the sake of order.

Dr SIMSON, in his Reſtoration of the Loci Plani, has deduced them from a propoſition of that book. *Vid. Loc. Plan. lib.* 2. *prop.* 5. *cor.* 1. & 3. The ſecond and fourth of Dr STEWART's Theorems are particular caſes of this propoſition, and are eaſily derived from it.

THEOREM VII. FIG. II.

Let there be any number, m, of given points A, B, C, &c. *and let* a, b, c, &c. *be given magnitudes, as many in number as there are given points, a point* X *may be found, ſuch, that if from* A, B, C, &c. *there be drawn ſtraight lines to any point* D, *and alſo to* X *the point found, and if* DX *be joined,*

$$a.AE^2+b.BD^2+c.CD^2 \text{ \&c.} = a.AX^2+b.BX^2+c.CX^2+(a+b+c)DX^2.$$

LET m be $= 3$. Suppoſe the point X found. Join DX; from the given points A, B, C draw AE, BF, CG perpendicular to DX, and join AX, BX, CX.

SINCE $a.AD^2+b.BD^2+c.CD^2=a.AX^2+b.BX^2+c.CX^2+(a+b+c)DX^2$; and

$$a.AD^2 = a.AX^2+a.DX^2-2a.DX.XE, \text{ and}$$
$$b.BD^2 = b.BX^2+b.DX^2+2b.DX.XF, \text{ and}$$
$$c.CD^2 = c.CX^2+c.DX^2+2c.DX.XG; \text{ or}$$

$a.AD^2+b.BD^2+c.CD^2 = a.AX^2+b.BX^2+c.CX^2+(a+b+c)DX^2+ 2DX(-a.XE+b.XF+c.XG)$; $a.XE$ muſt be equal, and in the oppoſite direction to $b.XF+c.XG$.

THIS will be effected by the following conſtruction:

JOIN AB, and divide it in H, ſo that $b.BH = a.AH$; that is, make $AH : BH = b : a$, and join HC, and divide it in X, ſo that $HX : CX = c : a+b$; or $(a+b)HX = c.CX$. Then X will be the point required.

FROM H draw to DX, the perpendicular HK.

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SINCE $a.AH = b.BH$, we ſhall have $a.EK = b.FK$; and ſince $(a+b)HX = c.CX$, we ſhall alſo have $(a+b)KX = c.GX$. Therefore ſince

$b.XF = b.FK - b.KX$, and

$c.XG = (a+b)KX$, we ſhall have

$b.XF + c.XG = b.FK + a.KX = a.EK + a.KX = a.XE$, and

$2DX(-a.XE + b.XF + c.XG) = 0$; therefore

$a.AD^2 + b.BD^2 + c.CD^2 = a.AX^2 + b.BX^2 + c.CX^2 + (a+b+c)DX^2$, or

$$AD^2 + \frac{b}{a}BD^2 + \frac{c}{a}CD^2 = AX^2 + \frac{b}{a}BX^2 + \frac{c}{a}CX^2 + \left(\frac{a+b+c}{a}\right)BX^2.$$

The point X is the centre of gravity of weights, proportional to the magnitudes a, b, c, &c. placed at the given points A, B, C, &c.

Cor. 1. LET any number, m, of circles be given by poſition, (fig. 3.) and about every circle let an equilateral figure be deſcribed, a point X may be found, ſuch, that if from any point C there be drawn perpendiculars to the ſides of the figures, and a ſtraight line to the point found, twice the ſum of the ſquares of the perpendiculars will be equal to the multiple of the ſquare of the line drawn to the point found, by the number of the ſides of the figures, together with a given ſpace.

LET m be $= 2$; let a be the number of the ſides of the figure deſcribed about the circle whoſe centre is A, b the number of the ſides of the figure deſcribed about the circle whoſe centre is B, CD, CE, CF, the perpendiculars to the ſides of the firſt figure, and CG, CH, CK, CL, the perpendiculars to the ſides of the ſecond.

JOIN the centres A, B, and divide AB in X, ſo that $AX : BX = b : a$, X will be the point required.

$2(CD^2 + CE^2 + CF^2) = 2a.AM^2 + a.AC^2$ (theor. 3.). In like manner,

$2(CG^2 + CH^2 + CK^2 + CL^2) = 2b.BN^2 + b.BC^2$. Therefore,

$2(CD^2 + CE^2 + CF^2 + CG^2 + CH^2 + CK^2 + CL^2) = 2a.AM^2 + 2b.BN^2 + a.AC^2 + b.BC^2$. But,

$a.AC^2+b.BC^2=(a+b)\ AX.BX+(a+b)\ CX^2$ (prop. 1.), and $2a.AM^2+2b.BN^2+(a+b)\ AX.BX$ are given ſpaces. Therefore $2(CD^2+CE^2+CF^2+CG^2+CH^2+CK^2+CL^2)=(a+b)\ CX^2+A^2$, A^2 being a given ſpace.

Cor. 2. Let any number of ſemicircles be given by poſition, and let an equilateral figure be deſcribed about every ſemicircle, a point may be found, ſuch, that if from any point there be drawn perpendiculars to all the ſides of the figures, and a ſtraight line to the point found, twice the ſum of the ſquares of the perpendiculars will be equal to the multiple of the ſquare of the line drawn to the point found, by the number of all the ſides, together with a given ſpace.

Cor. 3. Let any number of circles and ſemicircles be given by poſition, and about every circle and ſemicircle let an equilateral figure be deſcribed, a point may be found, ſuch, that if from any point there be drawn perpendiculars to all the ſides of the figures, and a ſtraight line to the point found, twice the ſum of the ſquares of the perpendiculars will be equal to the multiple of the line drawn to the point found, by the number of the ſides, together with a given ſpace.

THEOREM VIII. Fig. IV.

Let there be any number, m, of given points A, B, C, &c. *two points* X, Y, *may be found, ſuch, that if from any point* D *ſtraight lines be drawn to* A, B, C, &c. *and to* X, Y,

$$2(DA^2+DB^2+DG^2)=m(DX^2+DY^2).$$

This propoſition follows directly from theor. 6. Let $m=3$, and let E be the centre of gravity of the three points A, B, C. The ſquares of EA, EB, EC, are given, and conſequently a ſquare $=\frac{1}{3}(EA^2+EB^2+EC^2)$ may be found. On E with the diſtance EX equal

equal to the ſide of this ſquare, deſcribe a circle. The extremities X, Y, of any diameter, will be two ſuch points as are required. For

$DA^2+DB^2+DC^2 = EA^2+EB^2+EC^2+3.ED^2$, (Theor. 6.).

But $EA^2+EB^2+EC^2 = 3.EX^2$, therefore

$2(DA^2+DB^2+DC^2) = 6(EX^2+ED^2) = 3(DX^2+DY^2)$ (Prop. 1.).

THEOREM IX. FIG. IV.

Let there be any number, m, of given points A, B, C, &c. *and let a, b, c,* &c. *be given magnitudes, as many in number as there are given points, two points* X, Y, *may be found, ſuch, that if from any point* D *there be drawn ſtraight lines to* A, B, C, &c. *and to* X, Y,

$$DA^2+\frac{b}{a}DB^2+\frac{c}{a}DC^2 \text{ \&c.} = \left(\frac{a+b+c}{2a}\right)(DX^2+DY^2).$$

THIS propoſition follows, in the ſame manner, from theor. 7. Let m be $= 3$. Let E be a point ſuch that $DA^2+\frac{b}{a}DB^2+\frac{c}{a}DC^2 = EA^2+\frac{b}{a}EB^2+\frac{c}{a}EC^2+\left(\frac{a+b+c}{a}\right)ED^2$. On E as a centre, with the diſtance $EX = \sqrt{\frac{a}{a+b+c}(EA^2+\frac{b}{a}EB^2+\frac{c}{a}EC^2)}$ deſcribe a circle. The extremities X, Y, of any diameter, will be two ſuch points as are required. For

$$DA^2+\frac{b}{a}DB^2+\frac{c}{a}DC^2 = EA^2+\frac{b}{a}EB^2+\frac{c}{a}EC^2+\left(\frac{a+b+c}{a}\right)ED^2,$$

and $EA^2+\frac{b}{a}EB^2+\frac{c}{a}EC^2 = \left(\frac{a+b+c}{a}\right)EX^2$. Therefore,

2(DA²

$$2(DA^2+\frac{b}{a}DB^2+\frac{c}{a}DC^2)=2\left(\frac{a+b+c}{a}\right)(ED^2+EX^2) =$$

$$\left(\frac{a+b+c}{a}\right)(DX^2+DY^2), \text{ (Prop. 1.). Or,}$$

$$DA^2+\frac{b}{a}DB^2+\frac{c}{a}DC^2 = \left(\frac{a+b+c}{2a}\right)(DX^2+DY^2).$$

THEOREM X. Fig. V.

Let there be any number, m, of parallel ſtraight lines AB, CD, EF, &c. *given by poſition, a ſtraight line* XY *may be found parallel to them, ſuch, that if from any point* G, *perpendiculars* GA, GC, GE, &c. *be drawn to* AB, CD, EF, &c. *and the line* GX *perpendicular to* XY,

$GA^2+GC^2+GE^2$ &c. $= mGX^2+A^2$, A^2 *being a given ſpace.*

THIS propoſition is one of the ſimpleſt caſes of theor. 6. A line XY parallel to AB, drawn through X, the centre of gravity of the points A, C, E, where a perpendicular from G meets the parallels AB, CD, EF, will be the line required. For, $GA^2+GC^2+GE^2 = XA^2+XC^2+XE^2+3GX^2$ (Theor. 6.), and $XA^2+XC^2+XE^2$ is a given ſpace.

THEOREM XI. Fig. VI.

Let there be any number, m, of ſtraight lines AB, AC, AD, &c. *interſecting in a point* A, *ſo as to make all the angles round it equal; and from any point* E, *let perpendiculars* EB, EC, ED, &c. *be drawn to* AB, AC, AD, &c. *and let* AE *be joined,*

$$2(EB^2+EC^2+ED^2 \text{ \&c.}) = m.EA^2.$$

THIS

This propoſition follows directly from the firſt caſe of theor. 2. Let m be $= 3$. The points B, C, D, are in a circle of which EA is the diameter, and therefore (lemma 2.) the arches BC, CD, DB, are equal. Therefore,

$$2(EB^2+EC^2+ED^2) = 4.3.R^2 = 3.EA^2 \dagger.$$

Cor. 1. If AB, AC, AD, interſect one another in a given point A, and make all the angles round it equal; and if from any point E there be drawn perpendiculars to AB, AC, AD; and if the ſum of the ſquares of the perpendiculars be equal to a given ſpace, the point E will be in the circumference of a given circle.

The double of the given ſpace is $m.AE^2$, therefore AE is given in magnitude, and ſince the point A is given, the point E is in the circumference of a given circle.

* *Cor.* 2. If the circumference of a circle FGH, of which the radius is R, be divided into m number of equal parts, by the ſemidiameters AF, AG, AH, &c. making with any diameter EN the angles FAE, GAN, HAE, &c. twice the ſum of the ſquares of the ſines, or coſines of theſe angles will be $= mR^2$.

Let m be $= 3$.

$FK = EB$; $GL = EC$; $HM = ED$. Therefore $2(FK^2 + GL^2+HM^2) = 3EA^2 = 3R^2$. In the ſame manner, $AK = AB$; $AL = AC$; $AM = AD$. Therefore $2(AK^2+AL^2+AM^2) = 3.EA^2 = 3R^2$.

* LEMMA III. Fig. VII.

Let there be a figure ABCD *given in ſpecies inſcribed in a circle, the ſtraight line* EH *drawn from* E, *the centre of the circle, to* H, *the*

† R is the radius of the circle ABC.

the centre of gravity of the figure, will have a given ratio to the semidiameter, and will make given angles with the semidiameters, drawn to the angular points of the figure.

THE centre of gravity of the figure ABCD is found by bisecting AB in F, by joining FC and dividing it in G, so that $CG = 2GF$, and by joining GD and dividing it in H, so that $DH = 3HG$. Hence, and by joining BD and CA, the lemma will be manifest.

FOR the triangle BFE is right-angled in F, and the angle $BEF = ADB$, is given. Therefore the ratio of BE, or CE, to EF is given.

AGAIN, in the triangle CEF, the angle $CEF = BEC + BEF = 2BDC + ADB$ = a given angle; and since the ratio of CE to EF, and of CG to GF are given, the line EG will divide the triangle CFE into two triangles given in species. Therefore the angle CEG, and the ratio of CE, or DE, to EG, are given.

LASTLY, in the triangle DEG, the angle $DEG = 2DAC + CEG$, is given; and since the ratio of DE to EG, and of DH to HG, are given, the line EH will divide the triangle DEG into two triangles given in species. Therefore the angle DEH, and the ratio of DE to EH will be also given.

THEOREM XII. FIG. VIII.

Let there be any number, m, of straight lines AB, AC, AD, AE, &c. *given by position, intersecting one another in the point* A, *two straight lines* AX, AY, *may be found, which will be given by position, such, that if from any point* F *there be drawn the perpendiculars* FB, FC, FD, FE, &c. *to* AB, AC, AD, AE, &c. *and* FX, FY, *perpendicular to* AX, AY,

$$2(FB^2 + FC^2 + FD^2 + FE^2 \ \&c.) = m(FX^2 + FY^2).$$

LET

Let m be $= 4$. Let G be the centre of the circle which passes through A, B, C, D, E, F, and H the centre of gravity of the figure BCDE. Join GH, and through H draw XHY perpendicular to GH, meeting the circumference in X, Y, and join GB, GC, GD, GE; HB, HC, HD, HE, HF; AX, AY, FX, FY. Then, by Theor. 6. $GB^2+GC^2+GD^2+GE^2 =$
$4GB^2 = HB^2+HC^2+HD^2+HE^2+4HG^2$.
But $4GB^2 = 4GX^2 = 4(GH^2+XH^2)$. Therefore also,
$HB^2+HC^2+HD^2+HE^2+4HG^2 = 4(HG^2+HX^2)$; or,
$HB^2+HC^2+HD^2+HE^2 = 4HX^2$. Again, by Theor. 6.
$FB^2+FC^2+FD^2+FE^2 = HB^2+HC^2+HD^2+HE^2+4FH^2$, and therefore,
$FB^2+FC^2+FD^2+FE^2 = 4(FH^2+HX^2)$. That is,
$2(FB^2+FC^2+FD^2+FE^2) = 8(FH^2+HX^2) = 4(FX^2+FY^2)$, (Prop. 1.).

But because the lines AB, AC, AD, AE, are given by position, the angles BAC, CAD, DAE, BAE, are given; therefore the angles BGC, CGD, DGE, BGE, which are the doubles of them, are also given, and the isosceles triangles BGC, CGD, DGE, BGE, are given in species. Consequently, the ratio of the semidiameter GB to each of the lines BC, CD, DE, BE, is given, and therefore the ratios of BC, CD, DE, BE, to one another, are given; and the angles of the figure BCDE are also given, therefore the figure itself is given in species. Therefore (Lemma 3.) the ratio of GX to GH is given; and since the angle GHX is a right angle, the triangle GHX is given in species. Therefore the angles XGH, YGH, are given. But BGH is given, (Lemma 3.); therefore BGX, BGY, and their halves BAX, BAY, are also given; and since BA is given by position, and the point A, the lines AX, AY, are also given by position.

But FX, FY, are perpendicular to AX, AY, and it has been ſhewn that $2(FB^2+FC^2+FD^2+FE^2) = 4(FX^2+FY^2)$. Therefore AX, AY, are the two lines required to be found.

The conſtruction is obvious, by aſſuming a point F, which, for the greater ſimplicity, may be in one of the given lines, and by deſcribing the figure as above.

* *Cor.* If from any point parallels be drawn to AB, AC, AD, AE, and to AX, AY, cutting the perpendiculars FB, FC, FD, FE, and FX, FY, in b, c, d, e, and in x, y,

$$2(Fb^2+Fc^2+Fd^2+Fe^2) = 4(Fx^2+Fy^2).$$

* LEMMA IV. Fig. IX.

Let AB, AC, *be two ſtraight lines given by poſition, interſecting one another in the point* A, *and from any point* D *let* DB, DC, *be drawn perpendicular to* AB, AC; *let* CB *be joined, and biſected in* E, *and from* E *let* EF *be drawn parallel, and equal to a given ſtraight line; through* F *let* GFH *be drawn to meet* DB *and* DC, *ſo as to be biſected in* F, *and through* G *and* H *let* GK, HK, *be drawn parallel to* AB, AC: *the lines* GK, HK, *will be given by poſition.*

Through F draw LM parallel to BC, and through B and C draw BL and CM parallel to EF; join GL, HM; from A draw AN parallel and equal to EF; join LN, MN; through N draw OP parallel to GL; and join AO, AP.

Because GF = FH, and LF = FM, GL will be equal and parallel to HM; and becauſe AN is equal and parallel to BL and to CM, the figures AM and AL are parallelograms. Therefore NL is parallel to GK, and NM to HK. Therefore NG and NH are parallelograms, and OG = NL = AB; hence AO is perpendicular to GK; and, in the ſame manner, AP is perpendicular

dicular to HK. Therefore NO = LG = HM = NP. But the angle OAP is given, being the fupplement of OKP; and fince the point N is given, and NO = NP, the points O and P are given; and therefore AO and AP. Therefore the lines GK, HK, are given by pofition.

THEOREM XIII. FIG. X. No. 1.

Let there be any number, m, of ftraight lines AB, BC, CD, DA, &c. *given by pofition, neither all parallel nor interfecting in one point, two ftraight lines* XY, XZ, *may be found, which will be given by pofition, fuch, that if from any point* E, *there be drawn perpendiculars* EF, EG, EH, EK, &c. *to* AB, BC, CD, DA, &c. *and* EY, EZ, *perpendicular to* XY, XZ,

$$2(EF^2+EG^2+EH^2+EK^2 \text{ \&c.}) = m(EY^2+EZ^2)+A^2,$$

A^2 *being a given fpace.*

LET $m = 4$, and from C, one of the points of interfection, draw Cf, Ck, parallel to the lines given by pofition that do not interfect in C. Let two ftraight lines CL, CM be found, fuch, that $2(Ef^2+EG^2+EH^2+Ek^2)=4(EL^2+EM^2)$, (Theor. 12.). Let N be the centre of gravity of the four points F, G, H, K, (Theor. 6.). Through N draw YNZ to meet EL, EM in Y, Z, and fo as to be bifected in N. Through Y and Z draw YX, ZX perpendicular to EL, EM, interfecting each other in X. From X draw XP, XQ, XR, XS, perpendicular, and Xa, Xb, Xc, Xd, parallel to AB, BC, CD, DA; let Xa, Xb, Xc, Xd, meet EF, EG, EH, EK, in a, b, c, d; join XF, XG, XH, XK; NF, NG, NH, NK, NX; and let O be the centre of gravity of the four points f, G, H, k, where the parallels from C, to the lines given by pofition, meet the perpendiculars from E.

By theor. 6. $2(XF^2+XG^2+XH^2+XK^2) = 2(NF^2+NG^2+NH^2+NK^2)+8NX^2$. But $2(XF^2+XG^2+XH^2+XK^2) = 2(XP^2+XQ^2+XR^2+XS^2)+2(Xa^2+Xb^2+Xc^2+Xd^2)$. Therefore $2(NF^2+NG^2+NH^2+NK^2)+8NX^2 = 2(XP^2+XQ^2+XR^2+XS^2)+2(Xa^2+Xb^2+Xc^2+Xd^2)$. But since,
$2(Ef^2+EG^2+EH^2+Ek^2) = 4(EL^2+EM^2)$, and from the point X parallels to C*f*, CG, CH, C*k*, and to CL, CM, are drawn, cutting the perpendiculars from E, to these lines, in *a*, *b*, *c*, *d*, and in Y, Z, therefore, by Cor. Theor. 12.
$2(Ea^2+Eb^2+Ec^2+Ed^2) = 4(EY^2+EZ^2)$, and consequently
$2(Xa^2+Xb^2+Xc^2+Xd^2) = 4(XY^2+XZ^2) = 8(NY^2+NX^2)$, (Prop. 1.). Therefore,
$2(NF^2+NG^2+NH^2+NK^2) = 2(XP^2+XQ^2+XR^2+XS^2)+8NY^2$. But by Theor. 6.
$2(EF^2+EG^2+EH^2+EK^2) = 2(NF^2+NG^2+NH^2+NK^2)+8NE^2$. Therefore,
$2(EF^2+EG^2+EH^2+EK^2) = 2(XP^2+XQ^2+XR^2+XS^2)+8(NY^2+NE^2)$; or,
$2(EF^2+EG^2+EH^2+EK^2) = 2(XP^2+XQ^2+XR^2+XS^2)+4(EY^2+EZ^2)$, (Prop. 1.).

It remains to demonstrate that X is a given point, and that XY, XZ, are lines given in position.

The point O may be found, by bisecting (Fig. X. No. 2.) GH in *g*, joining *gk*, and dividing it in *m*, so that $gm = \frac{1}{3}gk$, and joining *fm* and dividing it in O, so that $mO = \frac{1}{4}mf$; and in the same manner the point N may be found by joining *g*K, and making $gn = \frac{1}{3}g$K, and joining *n*F, and making $n\text{N} = \frac{1}{4}n\text{F}$; let *mn* be joined, through O draw O*p*, and through N draw N*q*, both parallel to EF, and meeting *mn* in *p*, *q*; let EF meet *mn* in *r*, join ON, and through O draw O*s* parallel to *mn*, meeting N*q* in *s*.

Then because $gm = \frac{1}{3}gk$, and $gn = \frac{1}{3}g$K, the line *mn* is parallel and equal to $\frac{1}{3}$K*k*. Because also $\text{N}n = \frac{1}{4}\text{F}n$, $\text{N}q = \frac{1}{4}\text{F}r$; and

and for the ſame reaſon OP $= \frac{1}{4}fr$. Therefore $pq =$ Os $= \frac{1}{4}mn = \frac{1}{4}Kk$. But the angle O$s$N is given, for it is equal to kEF; and ſince Os is given, and Ns $=$ Nq—sq, NO is alſo given. But (Fig. 10. No. 1.) ſince the lines CL, CM, interſecting in the point C, are given by poſition, and from the point E there are drawn to them the perpendiculars EL, EM, and LM is joined, and biſected in O, and from O there is drawn a ſtraight line ON given both by poſition and magnitude, and YNZ is drawn through N to meet EL, EM in Y, Z, and ſo as to be biſected in N, and from Y and Z, YX, ZX are drawn parallel to CL, CM; therefore, by Lemma 4. YX, ZX are given by poſition; and conſequently the point X, of their interſection is given, and therefore alſo XP, XQ, XR, XS.

But EY, EZ, are perpendicular to XY, XZ; and it has been proved that $2(EF^2+EG^2+EH^2+EK^2) = 4(EY^2+EZ^2)+2(XP^2+XQ^2+XR^2+XS^2)$, and theſe four laſt ſquares are given. Therefore XY, XZ, are the two lines required to be found, and $2(EF^2+EG^2+EH^2+EK^2) = 4(EY^2+EZ^2)+A^2$.

The point X, found in this propoſition, is the centre of gravity of the four points P, Q, R, S, where perpendiculars, drawn from it, meet the four lines given by poſition. It is alſo a point, ſuch, that the ſum of the ſquares of the perpendiculars drawn from it, to the lines given by poſition, is a minimum.

Cor. If the ſtraight lines (Fig. 11.) AB, BC, CA, be ſo ſituated as to form an equilateral figure about a circle, or a ſemicircle; or if the number of the lines given by poſition be even, and every two and two interſect each other at right angles, the two lines XY, XZ, that may be found, will interſect each other at right angles.

Let the lines AB, BC, CA, that are given by poſition, form an equilateral triangle. Let X be the point in that triangle, which is the centre of gravity of the three points K, L, M, where

where perpendiculars drawn from it, meet the lines given by position; and from X let parallels be drawn to these lines, meeting the perpendiculars from any point E in *f*, *g*, *h*.

SINCE these parallels X*f*, X*g*, X*h*, intersect one another in the point X, so as to make all the angles round it equal, they will divide the circumference of the circle which passes through X and E, into three equal arches *fg*, *gh*, *hf*, (Lemma 2.). Therefore N, the centre of the circle, is the centre of gravity of the three points *f*, *g*, *h*, and the line YZ, passing through N, and meeting the circumference, will be a diameter of the circle, and therefore YXZ is a right angle.

THEOREM XIV. FIG. XII. &c.

Let any number, m, greater than 3, *of straight lines be given by position, three straight lines may be found, which will be given by position, such, that if from any point there be drawn perpendiculars to the lines given by position, and to the three lines found, thrice the sum of the squares of the perpendiculars to the lines given by position, will be equal to the sum of the squares of the perpendiculars drawn to three lines found, multiplied by the number m.*

LET m be $= 4$.

Case 1. WHEN the lines (Fig. 12.) AF, BG, CH, DK, given by position, are all parallel. Let a perpendicular from any point E meet the parallels in the points A, B, C, D, and let L be the centre of gravity of these points. Assume in AL any point X, and let Y and Z, on the opposite side of L, be such, that $LY+LZ = LX$, and also $LX^2+LY^2+LZ^2 = \frac{3}{4}(LA^2+LB^2+LC^2+LD^2)$; then if the assumed point X be given, the points Y and Z will also be given. Draw through the points X, Y, Z, straight lines parallel to AF, and they will be the lines required.

IT

It is plain that L is the centre of gravity of the points X, Y, Z, and becauſe it is alſo the centre of gravity of the points A, B, C, D,

$3(EA^2+EB^2+EC^2+ED^2) = 3(LA^2+LB^2+LC^2+LD^2)+$
$3.4.EL^2$, (Theor. 6.); and, for the ſame reaſon,
$4(EX^2+EY^2+EZ^2) = 4(LX^2+LY^2+LZ^2)+4.3.EL^2$.
But by conſtruction,
$3(LA^2+LB^2+LC^2+LD^2) = 4(LX^2+LY^2+LZ^2)$. Therefore,
$3(EA^2+EB^2+EC^2+ED^2) = 4(EX^2+EY^2+EZ^2)$.

Caſe 2. When the lines (Fig. 13.) AB, AC, AD, AE, given by poſition, interſect one another in the ſame point A.

Let G be the centre of gravity of the four points B, C, D, E, in the circumference of the circle of which AF is the diameter, (Theor. 6.), and let AH, AK, be two lines, whoſe poſition is given, ſuch, that $2(FB^2+FC^2+FD^2+FE^2) = 4(FH^2+FK^2)$, (Theor. 12.). From any point X in the circumference draw, through G, the line XGL, ſo that $XG = 2GL$; and through L draw YLZ to meet the circumference in Y, Z, and ſo as to be biſected in L. Join AX, AY, AZ, and FX, FY, FZ.

$3(FB^2+FC^2+FD^2+FE^2) = 6(FH^2+FK^2)$, (Theor. 12.), and $4(FX^2+FY^2+FZ^2) = 6(FH^2+FK^2) = 3(FB^2+FC^2+FD^2+FE^2)$. Therefore AX, AY, AZ, are the three lines required to be found.

Caſe 3. When the lines (Fig. 14. No. 1.) AB, BC, CD, DA, are not parallel, and do not interſect one another in the ſame point.

Let X be a point ſo related to the lines AB, BC, CD, DA, that it ſhall be the centre of gravity of the four points L, M, N, O, where they are interſected by the perpendiculars XL, XM, XN, XO, drawn to them from X, (Theor. 13.); and let XP, XQ, XR, XS, be drawn from X parallel to AB, BC, CD, DA, and let them meet the perpendiculars to theſe lines, from E, in

P,

P, Q, R, S. Let Xa, Xb, Xc, be three ſtraight lines, ſuch, that $3(EP^2+EQ^2+ER^2+ES^2) = 4(Ea^2+Eb^2+Ec^2)$, (Caſe 2. of this). Deſcribe a triangle def, (Fig. 14. No. 2.) having the angle $def = aXb$, and the angle $dfe = bXc$. Let g be a point in that triangle, ſuch, as to be the centre of gravity of the three points b, k, l, where perpendiculars drawn from it meet the ſides, (Theor. 13.). Deſcribe a ſquare $= \frac{3}{4}(XL^2+XM^2+XN^2+HO^2)$, and divide it into three ſquares whoſe ſides Xm, Xn, Xo, ſhall have the mutual ratios of gb, gk, gl. Through X draw Xm, Xn, Xo, perpendicular to Xa, Xb, Xc, and through m, n, o, draw mp, nq, qp, perpendicular to Xm, Xn, Xo, and meeting Ea, Eb, Ec, in x, y, z. We have, by Theor. 13.

$3(EF^2+EG^2+EH^2+EK^2) = 3(EP^2+EQ^2+ER^2+ES^2)+$
$3(XL^2+XM^2+XN^2+XO^2)$, and alſo
$4(Ex^2+Ey^2+Ez^2) = 4(Ea^2+Eb^2+Ec^2)+4(Xm^2+Xn^2+Xo^2)$.
But by conſtruction,
$3(EP^2+EQ^2+ER^2+ES^2) = 4(Ea^2+Eb^2+Ec^2)$, and by Caſe 2. of this, $3(XL^2+XM^2+XO^2+XN^2) = 4(Xm^2+Xn^2+Xo^2)$.
Therefore,
$3(EF^2+EG^2+EH^2+EK^2) = 4(Ex^2+Ey^2+Ez^2)$. Therefore mp, nq, qp, are the lines required to be found.

The three lines found in this Theorem are determined, in their poſition, only relatively to one another, and not abſolutely; becauſe, in the conſtruction of each of the caſes, an arbitrary ſuppoſition is unavoidably introduced, and of conſequence there are innumerable ſets of lines, within certain limits however, that all equally anſwer the conditions required in the propoſition. When one of theſe is aſſumed as given in poſition, the other two are neceſſarily determined.

The four propoſitions which follow in Dr Stewart's book are extenſions of four that have already been demonſtrated here, *viz.* the 10th, 12th, 13th and 14th; and are related to them juſt as the 7th of the preceding is to the fixth, or the 9th to the 8th. The purpoſe of them is to apply what has been demonſtrated

demonſtrated of the ſquares of the perpendiculars in Prop. 10. &c. to any rectilineal figures whatever, each given in ſpecies, deſcribed on thoſe perpendiculars.

THEIR demonſtrations are all derived in the ſame manner from thoſe of their correſponding propoſitions, and it will therefore be ſufficient, at preſent, to give the demonſtration of one of them. I have made choice of the 16th, as the 15th is only the ſimpleſt caſe of the 7th, *viz.* when all the points given, in that Theorem, are in the ſame ſtraight line.

THEOREM XVI. FIG. VIII.

Let there be any number, m, of ſtraight lines AB, AC, AD, AE, &c. *given by poſition, interſecting one another in the point* A, *and let a, b, c, d,* &c. *be given magnitudes, as many in number as there are lines given by poſition, two ſtraight lines* AX, AY, *may be found, which will be given by poſition, ſuch, that if from any point* F *there be drawn* FB, FC, FD, FE, &c. *perpendicular to* AB, AC, AD, AE, &c. *and* FX, FY, *perpendicular to* AX, AY,

$$FB^2 + \frac{b}{a}FC^2 + \frac{c}{a}FD^2 + \frac{d}{a}FE^2 \text{ \&c.} = \frac{a+b+c+d \text{ \&c.}}{2a}(FX^2 + FY^2).$$

LET $m = 4$. Let G be the centre of the circle which paſſes through the points A, B, C, D, E and F; and let H be the centre of gravity of weights proportional to the magnitudes *a, b, c, d,* placed at the points B, C, D and E. Join GH; and let XY, at right angles to GH in H, meet the circumference of the circle ABDF in X and Y: AX, AY, are the lines required to be found.

FOR it may be ſhown, juſt as in Theor. 12. by means of a lemma ſimilar to the 3d, that AX and AY make given angles

with AB, and are therefore given in poſition. But by Theor. 7.

$$GB^2+\frac{b}{a}GC^2+\frac{c}{a}GD^2+\frac{d}{a}GE^2=\frac{a+b+c+d}{a}GX^2=$$

$$HB^2+\frac{b}{a}HC^2+\frac{c}{a}HD^2+\frac{d}{a}HE^2=\frac{a+b+c+d}{a}GH^2.$$ Now,

$$\frac{a+b+c+d}{a}GX^2=\frac{a+b+c+d}{2a}(GX^2+GY^2)=$$

$$\frac{a+b+c+d}{a}(GH^2+HX^2),$$ by Prop. 1. Therefore,

$$HB^2+\frac{b}{a}HC^2+\frac{c}{a}HD^2+\frac{d}{a}HE^2=\frac{a+b+c+d}{a}HX^2.$$

Again, by Theor. 7. $FB^2+\frac{b}{a}FC^2+\frac{c}{a}FD^2+\frac{d}{a}FE^2=$

$HB^2+\frac{b}{a}HC^2+\frac{c}{a}HD^2+\frac{d}{a}HE^2+\frac{a+b+c+d}{a}HF^2$; therefore,

$FB^2+\frac{b}{a}FC^2+\frac{c}{a}FD^2+\frac{d}{a}FE^2=\frac{a+b+c+d}{a}(HX^2+HF^2)$, or, ſince

$HX^2+HF^2=\frac{1}{2}(FX^2+FY^2)$, $FB^2+\frac{b}{a}FC^2+\frac{c}{a}FD^2+\frac{d}{a}FE^2=$

$$\frac{a+b+c+d}{2a}(FX^2+FY^2).$$

Cor. If from any point, as F, ſtraight lines be drawn in given angles to the lines which are given by poſition, and which interſect in one point, two ſtraight lines may be found which will be given by poſition, ſuch, that if perpendiculars from F be drawn to them, the ſum of the ſquares of the lines drawn in given angles, will be equal to the ſpace to which the ſum of the ſquares of the perpendiculars has a given ratio.

This

This corollary is evident, becauſe the lines drawn from F, making given angles with AB, AC, &c. will have given ratios to the perpendiculars FB, FC, &c.

The 17th Theorem is, *That if a, b, c, &c. be any magnitudes as above, and if the figure be conſtructed as in Theor.* 13. (*Fig.* 10.), $EF^2+\frac{b}{a}EG^2+\frac{c}{a}EH^2+\frac{d}{a}EK^2$ &c. $=\frac{a+b+c+d+\&c.}{2a}(EY^2+EZ^2)+A^2$, A^2 *being a given ſpace.* This is demonſtrated from its relation to the 13th, in the ſame manner with the preceding, and ſo alſo is the 18th from the 14th. The 18th is, *That if a, b, c, &c. be any given magnitudes, and if the ſame things be ſuppoſed as in Theor.* 14. (*Fig.* 14.) *three ſtraight lines mp, nq, qp, may be found, ſuch, that* $EF^2+\frac{b}{a}EG^2+\frac{c}{a}EH^2+\frac{d}{a}EK^2$, &c. $=\frac{a+b+c+d\&c.}{3a}(Ex^2+Ey^2+Ez^2)$.

We proceed now to a propoſition that relates to the fourth powers of the perpendiculars.

THEOREM XXVII. Fig. XV.

Let there be any number, m, of given points A, B, C, &c. *two ſtraight lines may be found, which will be given by poſition, and likewiſe a point* D, *ſuch, that if from any point* E, *there be drawn* EY, EZ, *perpendicular to the two lines found, and if* EA, EB, EC, &c. *and* ED *be joined, then,* (*making* A^2 = *a given ſpace, and* B^4 = *the fourth power of a given line,*)

$$AE^4+BE^4+CE^4\ \&c. = mDE^4+A^2(EY^2+EZ^2)+B^4.$$

 Let

LET m be $= 3$. Let D be the centre of gravity of the three points A, B, C; join AD, BD, CD; from E draw EF, EG, EH perpendicular to AD, BD, CD; in AD take $DK = \frac{1}{3}AD$, in BD take $DL = \frac{1}{3}BD$, and in DC take $DM = \frac{1}{3}DC$. Then,

$$AE^2 = DE^2 + AD^2 - 2AD.DF$$
$$BE^2 = DE^2 + BD^2 + 2BD.DG$$
$$CE^2 = DE^2 + CD^2 - 2CD.DH. \text{ Therefore,}$$

$AE^4 = DE^4 + 2AD^2.DE^2 - 4AD^3.DF + AD^4 - 4DE^2.AD.DF + 4AD^2.DF^2$.

$BE^4 = DE^4 + 2BD^2.DE^2 + 4BD^3.DG + BD^4 + 4DE^2.BD.DG + 4BD^2.DG^2$.

$CE^4 = DE^4 + 2CD^2.DE^2 - 4CD^3.DH + CD^4 - 4DE.CD.DH + 4CD^2.DH^2$. But becauſe D is the centre of gravity of the three points A, B, C, $AD.DF + CD.DH = BD.DG$. Therefore, making $AE^4 + BE^4 + CE^4 = S^4$, we ſhall have

$$S^4 = 3DE^4 + 2\left\{\begin{array}{l} AD^2.DE^2 \\ BD^2.DE^2 \\ CD^2.DE^2 \end{array}\right\} + 4\left\{\begin{array}{l} -AD^3.DF \\ +BD^3.DG \\ -CD^3.DH \end{array}\right\} + 4\left\{\begin{array}{l} AD^2.DF^2 \\ BD^2.DG^2 \\ CD^2.DH^2 \end{array}\right\} + \left\{\begin{array}{l} AD^4 \\ BD^4 \\ CD^4 \end{array}\right\}.$$

But $DE^2 = EF^2 + DF^2 = EG^2 + DG^2 = EH^2 + DH^2$. Therefore,

$$S^4 = 3DE^4 + 2\left\{\begin{array}{l} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{array}\right\} + 6\left\{\begin{array}{l} AD^2.DF^2 \\ BD^2.DG^2 \\ CD^2.DH^2 \end{array}\right\} + 4\left\{\begin{array}{l} -AD^3.DF \\ +BD^3.DG \\ -CD^3.DH \end{array}\right\} + \left\{\begin{array}{l} AD^4 \\ BD^4 \\ CD^4 \end{array}\right\}.$$

$$\text{Or, } S^4 = 3DE^4 + 2\left\{\begin{array}{l} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{array}\right\} + \left\{\begin{array}{l} AD^2(6DF^2 - 4AD.DF + AD^2) \\ BD^2(6DG^2 + 4BD.DG + BD^2) \\ CD^2(6DH^2 - 4CD.DH + CD^2) \end{array}\right\}.$$

But $3DK = AD$; $3DL = BD$, and $3DM = CD$; and conſequently $9DK^2 = AD^2$, $9DL^2 = BD^2$, and $9DM^2 = CD^2$. Therefore, $S^4 = 3DE^4 +$

$$2\left\{\begin{array}{l} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{array}\right\} + \left\{\begin{array}{l} AD^2(6DF^2 - 12DK.DF + 6DK^2) \\ BD^2(6DG^2 + 12DL.DG + 6DL^2) \\ CD^2(6DH^2 - 12DM.DH + 6DM^2) \end{array}\right\} + \left\{\begin{array}{l} 3DK^2.AD^2 \\ 3DL^2.BD^2 \\ 3DM^2.CD^2 \end{array}\right\}.$$

Or,

$$\text{Or, } S^4 = 3DE^4 + 2\left\{\begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix}\right\} + 6\left\{\begin{matrix} AD^2.FK^2 \\ BD^2.LG^2 \\ CD^2.MH^2 \end{matrix}\right\} + \tfrac{1}{3}\left\{\begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix}\right\}.$$

Join EK, and on it as a diameter deſcribe the circle KFPENQ. draw the diameter FN and divide it in O, ſo that FO = 3ON, and through O draw PQ perpendicular to FN, meeting the circumference in P, Q; and join KP, KQ; EP, EQ. In the ſame manner, join EL, and on it as a diameter deſcribe the circle GVLRTE, draw the diameter GR, and divide it in S, ſo that GS = 3SR; through S draw TV perpendicular to GR, meeting the circumference in T, V; and join LT, LV, ET, EV. In the ſame manner alſo join EM, and on it as a diameter deſcribe the circle HZEX*a*M, draw the diameter HX, and divide it in Y, ſo that HY = 3YX; through Y draw Z*a* perpendicular to HX, meeting the circumference in Z, *a*; and join MZ, M*a*, EZ, E*a*. Then, FK = EN; LG = ER; and MH = EX. Therefore,

$$S^4 = 3DE^4 + 2\left\{\begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix}\right\} + 6\left\{\begin{matrix} AD^2.EN^2 \\ BD^2.ER^2 \\ CD^2.EX^2 \end{matrix}\right\} + \tfrac{1}{3}\left\{\begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix}\right\}. \quad \text{But}$$

$2EF^2+6EN^2=8FO.ON+8EO^2=8(OP^2+EO^2)=4(EP^2+EQ^2)$. In the ſame manner, $2EG^2+6ER^2 = 8GS.SR+8ES^2 = 8(TS^2+ES^2) = 4(ET^2+EV^2)$. In the ſame manner alſo, $2EH^2+6EX^2 = 8HY.YX+8EY^2 = 8(ZY^2+EY^2) = 4(EZ^2+Ea^2)$. Therefore,

$$S^4 = 3DE^4 + 4\left\{\begin{matrix} AD^2(EP^2+EQ^2) \\ BD^2(ET^2+EV^2) \\ CD^2(EZ^2+Ea^2) \end{matrix}\right\} + \tfrac{1}{3}\left\{\begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix}\right\}. \quad \text{Since then there}$$

are ſix ſtraight lines KP, KQ, LT, LV, MZ, M*a*, given by poſition, and given quantities $4AD^2$, $4AD^2$, $4BD^2$, $4BD^2$, $4CD^2$, $4CD^2$, as many in number as there are lines given by poſition, therefore, by Theor. 17. two ſtraight lines, *xy*, *xz*, may be found, which will be given by poſition, ſuch, that if from the point

point E, the perpendiculars EP, EQ, ET, EV, EZ, Ea, be drawn to KP, KQ, LT, LV, MZ, Ma, and if the perpendiculars Ey, Ez, be drawn to xy, xz, $4AD^2.EP^2+4AD^2.EQ^2+4BD^2.ET^2+4BD^2.EN^2+4CD^2.EZ^2+4CD^2.Ea^2 =$ $8(AD^2+BD^2+CD^2)(Ey^2+Ez^2)+a^4$. Therefore, $S^4 = 3DE^4+A^2(Ey^2+Ez^2)+a^4+\frac{1}{3}(AD^4+BD^4+CD^4)$. Or, $S^4 = 3DE^4+A^2(Ey^2+Ez^2)+B^4$.
Therefore xy, xz, are the lines, and D the point, required to be found.

THEOREM XXVIII.

Let there be any number, m, of given points A, B, C, *&c. and let a, b, c, &c. be given magnitudes, as many in number as there are given points, two ſtraight lines, zy, xz, may be found, which will be given by poſition, and likewiſe a point* D, *ſuch, that if from any point* E, *there be drawn perpendiculars* Ey, Ez, *to the two lines found, and if* EA, EB, EC, ED, *be joined,*

$$AE^2+\frac{b}{a}BE^2+\frac{c}{a}CE^2\&c. = \frac{a+b+c+\&c.}{a}DE^2+A^2(Ey^2+Ez^2)+B^4.$$

The inveſtigation is perfectly ſimilar to the former; only the point D is not the centre of gravity of the points A, B, C, &c. but, as in Theor. 7. the centre of gravity of weights, ſuppoſed to be placed in thoſe points, and proportional to the magnitudes a, b, c, &c.

The univerſality of the preceding demonſtrations is no way affected by our having always ſuppoſed m equal to ſome particular number, becauſe the reaſoning is the ſame, whatever value be aſſigned to it.

XIII.

[PLATE I. *To fold out, facing page* 134. *Phys. Cl.*]

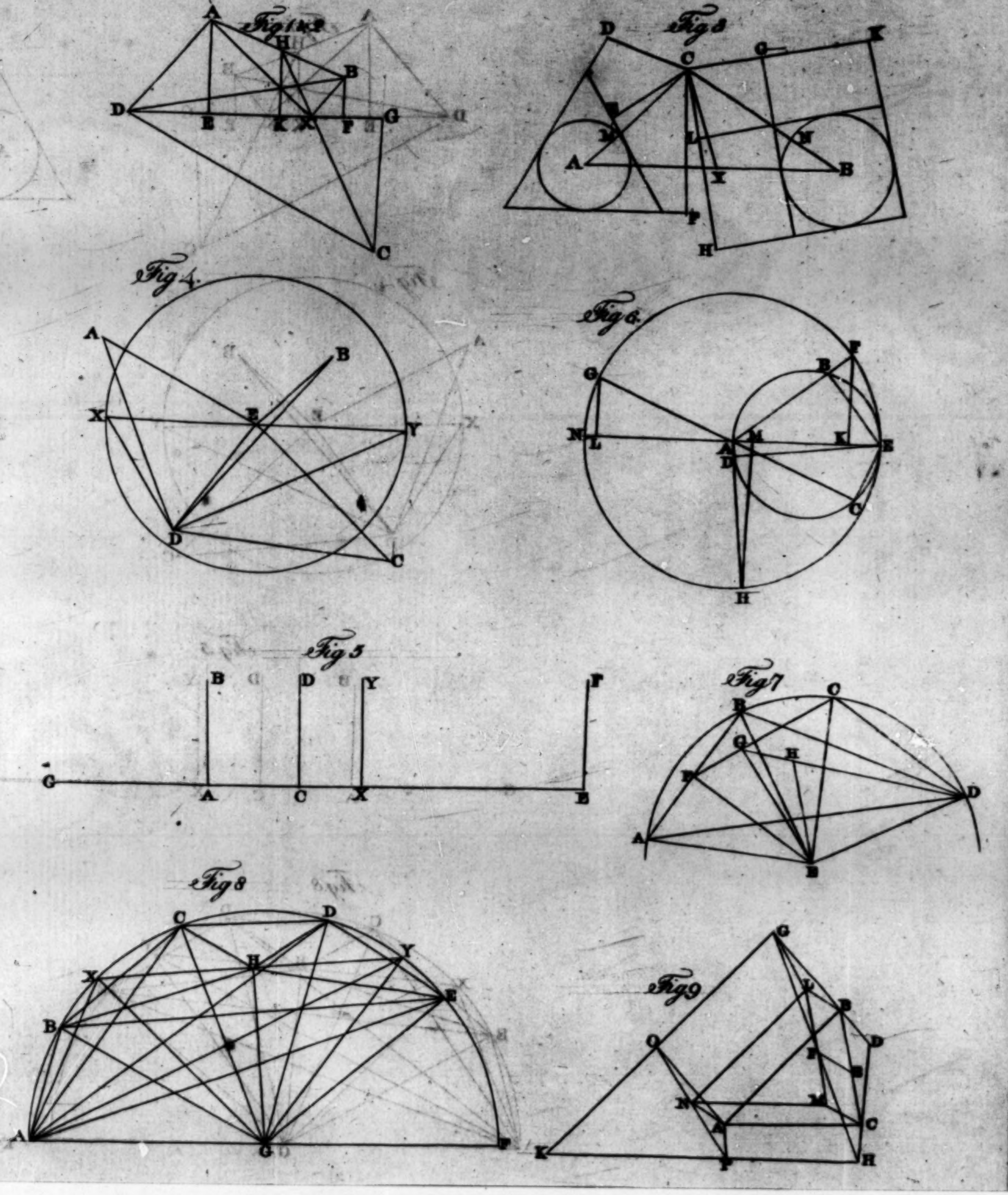


Fig. 10. N°1.

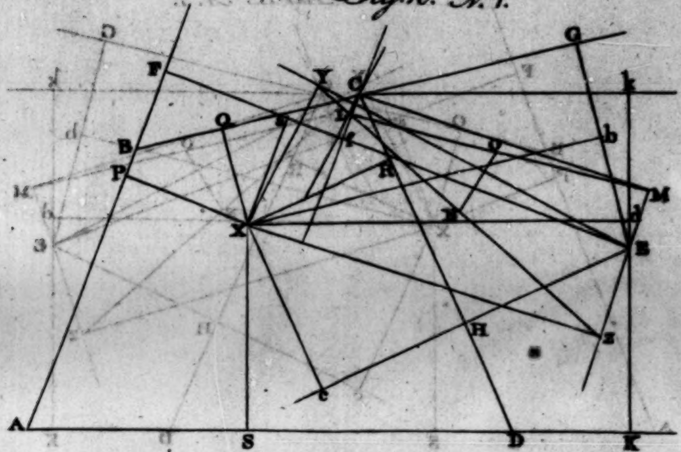


Fig. 10. N°2.

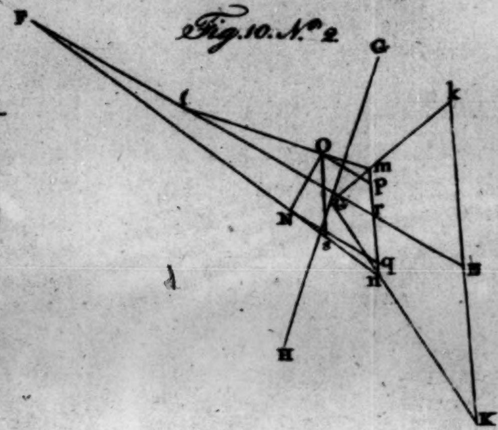


Fig. 12

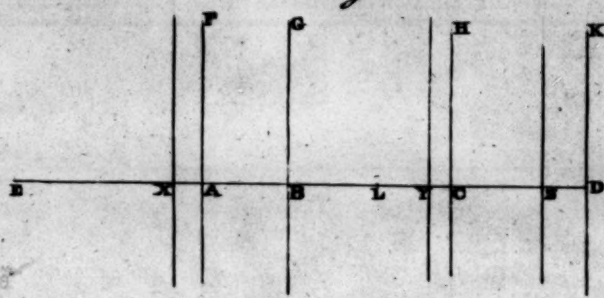


Fig. 11

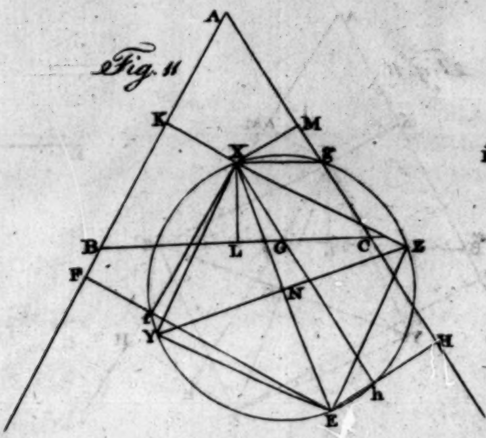


Fig. 13.

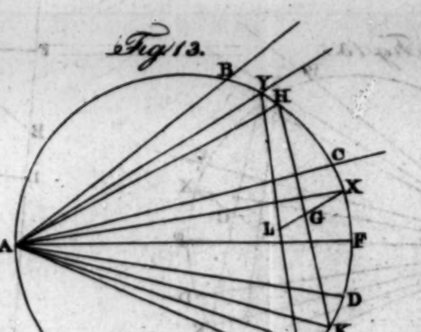


Fig. 14. N°1.

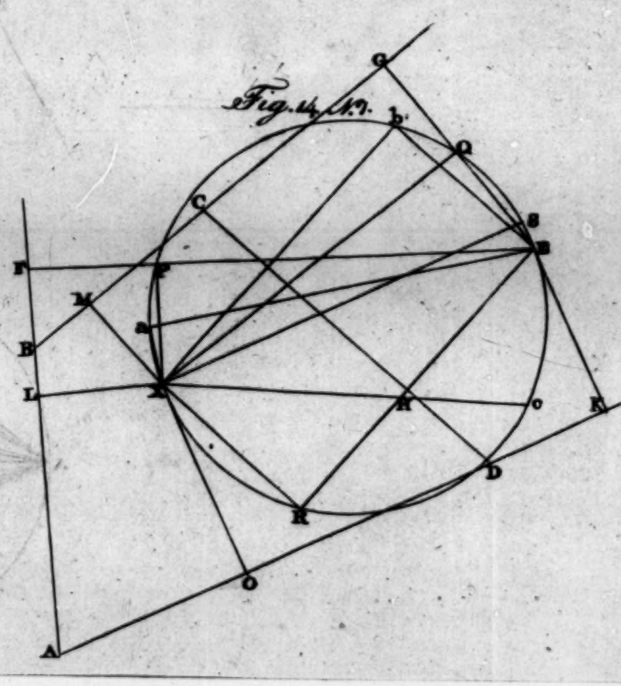


Fig. 14. No. 2

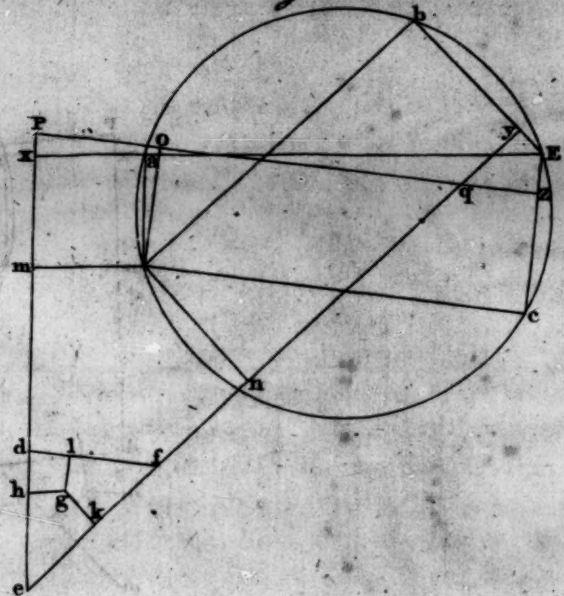
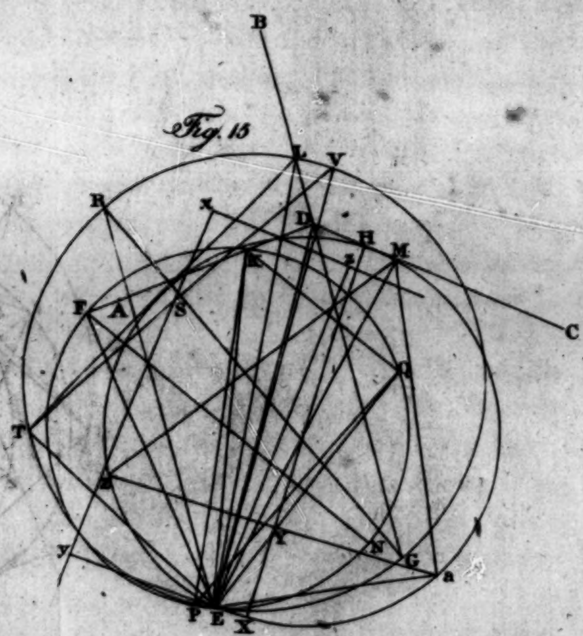


Fig. 15



XIII. REMARKS *on the* ASTRONOMY *of the* BRAHMINS. *By* JOHN PLAYFAIR, A. M. F. R. S. EDIN. *and Professor of Mathematics in the University of Edinburgh.*

[*Read by the Author, March* 2. 1789.]

I. SINCE the time when Astronomy emerged from the obscurity of ancient fable, nothing is better known than its progress through the different nations of the earth. With the era of NABONASSAR, regular observations began to be made in Chaldea; the earliest which have merited the attention of succeeding ages. The curiosity of the Greeks was, soon after, directed to the same object; and that ingenious people was the first that endeavoured to explain, or connect by theory, the various phenomena of the heavens. This work was supposed to be so fully accomplished in the Syntaxis of PTOLEMY, that his system, without opposition or improvement, continued, for more than five hundred years, to direct the Astronomers of Egypt, Italy and Greece. After the sciences were banished from Alexandria, his writings made their way into the east, where, under the Caliphs of Bagdat, Astronomy was cultivated with diligence and success. The Persian Princes followed the example of those of Bagdat, borrowing besides, from Trebisond, whatever mathematical knowledge was still preserved among the ruins of the Grecian empire. The conquests of GENGIS, and afterwards of TIMOUR, though they retarded, did not stop the progress of Astronomy in the east. The grandsons of these two conquerors were equally renowned for their

their love of ſcience: HULAGU reſtored Aſtronomy in Perſia, and ULUGH-BEIGH, by an effort ſtill more ſingular, eſtabliſhed it in Tartary. In the mean time, having paſſed with the Arabs into Spain, it likewiſe found, in ALPHONSO of Caſtile, both a diſciple and a patron. It was carried, ſoon after, into the north of Europe, where, after exerciſing the genius of COPERNICUS, of KEPLER, and of NEWTON, it has become the moſt perfect of all the ſciences.

2. IN the progreſs which Aſtronomy has thus made, through almoſt all the nations, from the Indus to the Atlantic, there is ſcarce a ſtep which cannot be accurately traced; and it is never difficult to determine what each age, or nation received from another, or what it added to the general ſtock of aſtronomical knowledge. The various ſyſtems, that have prevailed in all theſe countries, are viſibly connected with one another; they are all derived from one original, and would incline us to believe, that the manner in which men begin to obſerve the heavens, and to reaſon about them, is an experiment on the human race, which has been made but once.

IT is, therefore, matter of extreme curioſity to find, beyond the Indus, a ſyſtem of aſtronomical knowledge that appears to make no part of the great body of ſcience, which has traverſed, and enlightened the other countries of the earth; a ſyſtem that is in the hands of men, who follow its rules without underſtanding its principles, and who can give no account of its origin, except that it lays claim to an antiquity far beyond the period, to which, with us, the hiſtory of the heroic ages is ſuppoſed to extend.

3. WE owe our firſt knowledge of this aſtronomy to M. LA LOUBERE, who, returning, in 1687, from an embaſſy to Siam, brought with him an extract from a Siameſe manuſcript, which contained tables, and rules, for calculating the places of the ſun and moon *. The manner in which theſe rules were laid down

* Mem. de l'Acad. des Sciences, tom. 8. p. 281. &c.

down, rendered the principles, on which they were founded, extremely obſcure; and it required a commentator, as converſant with aſtronomical calculation as the celebrated CASSINI, to explain the meaning of this curious fragment. After that period, two other ſets of aſtronomical tables were ſent to Paris, by the miſſionaries in HINDOSTAN; but they remained unnoticed, till the return of M. LE GENTIL from India, where he had been to obſerve the tranſit of Venus in 1769. This Academician employed himſelf, during the long ſtay, which his zeal for ſcience induced him to make in that country, in acquiring a knowledge of the Indian aſtronomy. The Brahmins thought they ſaw, in the buſineſs of an Aſtronomer, the marks of a *Caſt*, that had ſome affinity to their own, and began to converſe with M. LE GENTIL, more familiarly than with other ſtrangers. A learned Brahmin of Tirvalore, having made a viſit to the French Aſtronomer, inſtructed him in the methods, which he uſed for calculating eclipſes of the ſun and moon, and communicated to him the tables and rules, that are publiſhed in the Memoirs of the Academy of Sciences, for 1772. Since that time, the ingenious and eloquent author of the Hiſtory of Aſtronomy, has dedicated an entire volume to the explanation, and compariſon of theſe different tables, where he has deduced, from them, many intereſting concluſions *. The ſubject indeed merited his attention; for the Indian aſtronomy has all the preciſion neceſſary for reſolving the great queſtions, with reſpect to its own origin and antiquity, and is by no means among the number of thoſe imperfect fragments of ancient knowledge, which can lead no farther than conjecture, and which an Aſtronomer would gladly reſign to the learned reſearches of the Antiquary, or the Mythologiſt.

4. IT is from theſe ſources, and chiefly from the elaborate inveſtigations of the laſt mentioned work, that I have ſelected

* Traité de l'Aſtronomie Indienne et Orientale, par M. BAILLY. Paris, 1787.

the materials of the paper, which I have now the honour to lay before this Society; and it is perhaps neceſſary that I ſhould make ſome apology for preſenting here, what can have ſo little claim to originality. The fact is, that notwithſtanding the moſt profound reſpect, for the learning and abilities of the author of the *Aſtronomie Indienne*, I entered on the ſtudy of that work, not without a portion of the ſcepticiſm, which whatever is new and extraordinary in ſcience ought always to excite, and ſet about verifying the calculations, and examining the reaſonings in it, with the moſt ſcrupulous attention. The reſult was, an entire conviction of the accuracy of the one, and of the ſolidity of the other; and I then fancied, that, in an argument of ſuch variety, I might perhaps do a ſervice to others, by preſenting to them, that particular view of it, which had appeared to me the moſt ſtriking. Such, therefore, is the object of theſe remarks; they are directed to three different points: The firſt is to give a ſhort account of the Indian aſtronomy, ſo far as it is known to us, from the four ſets of tables above mentioned; the ſecond, to ſtate the principal arguments, that can be deduced from theſe tables, with reſpect to their antiquity; and the third, to form ſome eſtimate of the geometrical ſkill, with which this aſtronomical ſyſtem is conſtructed. In the firſt, I have followed M. BAILLY cloſely; in the ſecond, though I have ſometimes taken a different road, I have always come to the ſame concluſion; having aimed at nothing ſo much, as to reduce the reaſoning into a narrow compaſs, and to avoid every argument that is not purely aſtronomical, and independent of all hypotheſis; in the third, I have treated of a queſtion which did not fall within the plan of M. BAILLY's work, but have only entered on it at preſent, leaving to ſome future opportunity, the other diſcuſſions to which it leads.

5. THE aſtronomy of India, as you already perceive, is confined to one branch of the ſcience. It gives no theory, nor even any deſcription of the celeſtial phenomena, but ſatisfies itſelf

itſelf with the calculation of certain changes in the heavens, particularly of the eclipſes of the ſun and moon, and with the rules and tables by which theſe calculations muſt be performed. The Brahmin, ſeating himſelf on the ground, and arranging his ſhells before him, repeats the enigmatical verſes that are to guide his calculation, and from his little tablets of palm leaves, takes out the numbers that are to be employed in it. He obtains his reſult with wonderful certainty and expedition; but having little knowledge of the principles on which his rules are founded, and no anxiety to be better informed, he is perfectly ſatisfied, if, as it uſually happens, the commencement and duration of the eclipſe anſwer, within a few minutes, to his prediction. Beyond this his aſtronomical enquiries never extend; and his obſervations, when he makes any, go no farther than to determine the meridian line, or the length of the day, at the place where he obſerves.

THE objects, therefore, which this aſtronomy preſents to us, are principally three. 1. Tables and rules for calculating the places of the ſun and moon: 2. Tables and rules for calculating the places of the planets: 3. Rules by which the phaſes of eclipſes are determined. Though it is chiefly to the firſt of theſe that our attention at preſent is to be directed, the two laſt will alſo furniſh us with ſome uſeful obſervations.

6. THE Brahmins, like all other Aſtronomers, have diſtinguiſhed from the reſt of the heavens, that portion of them, through which the ſun, moon and planets continually circulate. They divide this ſpace, which we call the zodiac, into twenty-ſeven equal parts, each marked by a group of ſtars, or a conſtellation *. This diviſion of the zodiac is extremely natural in the infancy of aſtronomical obſervation; becauſe the moon completes her circle among the fixed ſtars, nearly in twenty-ſeven days, and ſo makes an actual diviſion of that circle

ſ 2 into

* Mem. ſur l'Aſtronomie des Indiens, par M. LE GENTIL, Hiſt. de l'Acad. des Scien. 1772, II. P. 207. The phraſe which we here tranſlate *conſtellations*, ſignifies *the places of the moon in the twelve ſigns*.

into twenty-ſeven equal parts. The moon too, it muſt be remembered, was, at that time, the only inſtrument, if we may ſay ſo, by which the poſitions of the ſtars on each ſide of her path could be aſcertained; and when her own irregularities were unknown, ſhe was, by the rapidity of her motion eaſtward, well adapted for this purpoſe. It is alſo to the phaſes of the moon, that we are to aſcribe the common diviſion of time into weeks, or portions of ſeven days, which ſeems to have prevailed almoſt over the whole earth *. The days of the week are dedicated by the Brahmins, as by us, to the ſeven planets, and what is truly ſingular, they are arranged preciſely in the ſame order.

7. WITH the conſtellations, that diſtinguiſh the twenty-ſeven equal ſpaces, into which their zodiac is divided, the Aſtronomers of India have connected none of thoſe figures of animals, which are among us, of ſo ancient, and yet ſo arbitrary an original. M. LE GENTIL has given us their names, and configurations †. They are formed, for the moſt part, of ſmall groups of ſtars, ſuch as the Pleiades or the Hyades, thoſe belonging to the ſame conſtellation being all connected by ſtraight lines. The firſt of them, or that which is placed at the beginning of their zodiac, conſiſts of ſix ſtars, extending from the head of Aries to the foot of Andromeda, in our zodiac, and occupying a ſpace of about ten degrees in longitude. Theſe conſtellations are far from including all the ſtars in the zodiac. M. LE GENTIL remarks, that thoſe ſtars ſeem to have been ſelected, which are beſt adapted for marking out, by lines drawn between them, the places of the moon in her progreſs through the heavens.

AT the ſame time that the ſtars in the zodiac are thus arranged into twenty-ſeven conſtellations, the ecliptic is divided, as with us, into twelve ſigns of thirty degrees each. This diviſion

* Mem. Acad. des Scien. 1772. II. P. 189.

† Ibid. 209.

viſion is purely ideal, and is intended merely for the purpoſe of calculation. The names and emblems by which theſe ſigns are expreſſed, are nearly the ſame as with us *; and as there is nothing in the nature of things to have determined this coincidence, it muſt, like the arrangement of the days of the week, be the reſult of ſome ancient and unknown communication.

8. THAT motion by which the fixed ſtars all appear to move eaſtward, and continually to increaſe their diſtance from the place, that the ſun occupies at the vernal equinox, is known to the Brahmins, and enters into the compoſition of all their tables †. They compute this motion to be at the rate of 54″ a-year; ſo that their *annus magnus*, or the time in which the fixed ſtars complete an entire revolution, is 24,000 years. This motion is too quick by ſomewhat leſs than 4″ a-year; an error that will not be thought great, when it is conſidered, that PTOLEMY committed one of 14″, in determining the ſame quantity.

ANOTHER circumſtance, which is common to all the tables, and, at the ſame time, peculiar to the Indian aſtronomy, is, that they expreſs the longitude of the ſun and moon, by their diſtance from the beginning of the moveable zodiac, and not, as is uſual with us, by their diſtance from the point of the vernal equinox. The longitude is reckoned in ſigns of 30°, as already mentioned, and each degree is ſubdivided into 60′, &c. In the diviſion of time, their arithmetic is purely ſexageſimal: They divide the day into 60 hours, the hour into 60 minutes, &c.; ſo that their hour is 24 of our minutes, their minute 24 of our ſeconds, and ſo on.

9. THESE

* Mem. Acad. des Scien. 1772. II. P. 200. The zodiac they call *ſodi mandalam*, or the circle of ſtars.

† Ibid. 194. Aſt. Indienne, p. 43, &c.

9. These remarks refer equally to all the tables. We are now to take notice of what is peculiar to each, beginning with thoſe of Siam.

In order to calculate for a given time, the place of any of the celeſtial bodies, three things are requiſite. The firſt is, the poſition of the body in ſome paſt inſtant of time, aſcertained by obſervation; and this inſtant, from which every calculation muſt ſet out, is uſually called the *epoch* of the tables. The ſecond requiſite is, the mean rate of the planet's motion, by which is computed the arch in the heavens, that it muſt have deſcribed, in the interval between the epoch and the inſtant for which the calculation is made. By the addition of this, to the place at the epoch, we find the mean place of the planet, or the point it would have occupied in the heavens, had its motion been ſubject to no irregularity. The third is, the correction, on account of ſuch irregularity, which muſt be added to the mean place, or ſubtracted from it, as circumſtances require, in order to have the true place. The correction thus made is, in the language of aſtronomy, called an equation; and, when it ariſes from the eccentricity of a planet's orbit, it is called the equation of the centre.

10. The epoch of the tables of Siam does not go back to any very remote period. M. Cassini, by an ingenious analyſis of their rules, finds that it correſponds to the 21ſt of March, in the year 638 of our era, at 3 in the morning, on the meridian of Siam *. This was the inſtant at which the aſtronomical year began, and at which both the ſun and moon entered the moveable zodiac. Indeed, it is to be obſerved, that, in all the tables, the aſtronomical year begins when the ſun enters the moveable zodiac, ſo that the beginning of this year is continually advancing with reſpect to the ſeaſons, and makes the complete round of them in 24,000 years.

From

* Mem. Acad. Scien. tom. 8. p. 312. Aſt. Indienne, p. 11. § 14.

From the epoch above mentioned, the mean place of the sun for any other time is deduced, on the supposition that in 800 years, there are contained 292,207 days *. This supposition involves in it the length of the sydereal year, or the time that the sun takes to return to the beginning of the moveable zodiac, and makes it consist of 365 *d.* 6 *h.* 12′, 36″ †. From this, in order to find the tropical year, or that which regulates the seasons, we must take away 21′, 55″, as the time which the sun takes to move over the 54″, that the stars are supposed to have advanced in the year; there will remain 365 *d.* 5 *h.* 50′, 41″, which is the length of the tropical year that is involved, not only in the tables of Siam, but likewise, very nearly, in all the rest ‡. This determination of the length of the year is but 1′, 53″, greater than that of De la Caille, which is a degree of accuracy beyond what is to be found in the more ancient tables of our astronomy.

II. The next thing with which these tables present us, is a correction of the sun's mean place, which corresponds to what we call the equation of his centre, or the inequality arising from the eccentricity of his orbit, in consequence of which, he is alternately retarded and accelerated, his true place being, for one half of the year, left behind the mean, and, for the other, advanced before it. The point where the sun is placed, when his motion is slowest, we call his apogee, because his distance from the earth is then greatest; but the Indian astronomy, which is silent with respect to theory, treats this point as nothing more than what it appears to be, a point, *viz.* in the heavens, where the sun's motion is the slowest possible, and about 90° distant from that, where his greatest inequality takes place. This greatest inequality is here made to be

* Ast. Ind. p. 7. § 6.

† Mem. Acad. Scien. tom. 8. p. 328.

‡ Ast. Ind. p. 124. The tables of Tirvalore make the year 6″ less.

be 2°, 12′ *, about 16′ greater than it is determined, by the modern aſtronomy of Europe. This difference is very conſiderable; but we ſhall find that it is not to be aſcribed wholly to error, and that there was a time when the inequality in queſtion was nearly of the magnitude here aſſigned to it. In the other points of the ſun's path, this inequality is diminiſhed, in proportion to the ſine of the mean diſtance from the apogee, that is, nearly as in our own tables. The apogee is ſuppoſed to be 80° advanced beyond the beginning of the zodiac, and to retain always the ſame poſition among the fixed ſtars, or to move forward at the ſame rate with them †. Though this ſuppoſition is not accurate, as the apogee gains upon the ſtars about 10″ annually, it is much nearer the truth than the ſyſtem of PTOLEMY, where the ſun's apogee is ſuppoſed abſolutely at reſt, ſo as continually to fall back among the fixed ſtars, by the whole quantity of the preceſſion of the equinoxes ‡.

12. IN theſe tables, the motions of the moon are deduced, by certain intercalations, from a period of nineteen years, in which ſhe makes nearly 235 revolutions; and it is curious to find at Siam, the knowledge of that cycle, of which the invention was thought to do ſo much honour to the Athenian Aſtronomer METON, and which makes ſo great a figure in our modern

* THE equation of the ſun, or what they call the *chaiaa*, is calculated in the Siameſe tables only for every 15° of the *matteiomme*, or mean anomaly. CASSINI, *ubi ſupra*, p. 299.

† Aſt. Ind. p. 9.

‡ THE error, however, with reſpect to the apogee, is leſs than it appears to be; for the motion of the Indian zodiac, being nearly 4″ ſwifter than the ſtars, is but 6″ ſlower than the apogee. The velocity of the Indian zodiac is indeed neither the ſame with that of the ſtars, nor of the ſun's apogee, but nearly a mean between them.

modern kalendars *. The moon's apogee is ſuppoſed to have been in the beginning of the moveable zodiac, 621 days after the epoch of the 21ſt of March 638, and to make an entire revolution in the heavens in the ſpace of 3232 days †. The firſt of theſe ſuppoſitions agrees with MAYER's tables to leſs than a degree, and the ſecond differs from them only by 11^h, 14′, 31″; and if it be conſidered that the apogee is an ideal point in the heavens, which even the eyes of an aſtronomer cannot directly perceive, to have diſcovered its true motion, ſo nearly, argues no ſmall correctneſs of obſervation.

13. FROM the place of the apogee, thus found, the inequalities of the moon's motion, which are to reduce her mean to her true place, are next to be determined. Now, at the oppoſitions and conjunctions, the two greateſt of the moon's inequalities, the equation of the centre and the evection, both depend on the diſtance from the apogee, and therefore appear but as one inequality. They alſo, partly, deſtroy one another; ſo that the moon is retarded or accelerated, only by their difference, which, when greateſt, is, according to MAYER's tables, 4°, 57′, 42″. The Siameſe rules, which calculate only for oppoſitions and conjunctions, give, accordingly, but one inequality to the moon, and make it, when greateſt, 4°, 56′, not 2′ leſs than the preceding. This greateſt equation is applied, when the moon's mean diſtance from the apogee is 90°; in other ſituations, the equation is leſs, in proportion as the ſine of that diſtance diminiſhes ‡.

14. THE Siameſe MS. breaks off here, and does not inform us how the aſtronomers of that country proceed, in the remaining parts of their calculation, which they ſeem to have under-

* THE Indian period is more exact than that of our golden number, by 35′. Aſt. Ind. p. 5. The Indians regulate their feſtivals by this period. *Ibid.* Diſc. Prelim. p. viii.

† Aſt. Ind. p. 11. & 20.

‡ Aſt. Indienne, p. 13. CASSINI Mem. Acad. tom. 8. p. 304.

undertaken, merely for ſome purpoſe in aſtrology. M. CASSINI, to whom we are indebted for the explanation of theſe tables, obſerves, that they are not originally conſtructed for the meridian of Siam, becauſe the rules direct to take away 3′ for the ſun, and 40′ for the moon, (being the motion of each for 1^h, 13′), from their longitudes calculated as above *. The meridian of the tables is therefore 1^h, 13′, or 18°, 15′, weſt of Siam; and it is remarkable, that this brings us very near to the meridian of Benares, the ancient ſeat of Indian learning †. The ſame agrees nearly with what the Hindoos call their firſt meridian, which paſſes through Ceylon and the Banks of Ramanancor. We are, therefore, authoriſed, or rather, we are neceſſarily determined to conclude, that the tables of Siam came originally from HINDOSTAN.

15. ANOTHER ſet of aſtronomical tables, now in the poſſeſſion of the Academy of Sciences, was ſent to the late M. DE L'ISLE from Chriſnabouram, a town in the Carnatic, by Father DU CHAMP, about the year 1750. Though theſe tables have an obvious affinity to what have already been deſcribed, they form a much more regular and extenſive ſyſtem of aſtronomical knowledge. They are fifteen in number; and include, beſide the mean motions of the ſun, moon and planets, the equations to the centre of the ſun and moon, and two corrections for each of the planets, the one of which correſponds to its apparent, and the other to its real inequality. They are accompanied alſo with precepts, and examples, which Father DU CHAMP received from the Brahmins of Chriſnabouram, and which he has tranſlated into French ‡.

THE

* Mem. Acad. Scien. tom. 8. p. 302. & 309.

† Aſt. Ind. p. 12. It brings us to a meridian 82°, 34′, eaſt of Greenwich. Benares is 83°, 11′, eaſt of the ſame, by RENNEL's map.

‡ Theſe tables are publiſhed by M. BAILLY, Aſt. Ind. p. 335, &c. See alſo p. 31, &c.

The epoch of theſe tables is leſs ancient than that of the former, and anſwers to the 10th of March at ſunriſe, in the year 1491 of our era, when the ſun was juſt entering the moveable zodiac, and was in conjunction with the moon; two circumſtances, by which almoſt all the Indian eras are diſtinguiſhed. The places, which they aſſign, at that time, to the ſun and moon, agree very well with the calculations made from the tables of MAYER, and DE LA CAILLE. In their mean motions, they indeed differ ſomewhat from them; but as they do ſo equally for the ſun and moon, they produce no error, in determining the relative poſition of theſe bodies, nor, of conſequence, in calculating the phenomena of eclipſes. The ſun's apogee is here ſuppoſed to have a motion ſwifter than that of the fixed ſtars, by about 1″ in nine years, which, though it falls greatly ſhort of the truth, does credit to this aſtronomy, and is a ſtrong mark of originality. The equation of the ſun's centre is ſomewhat leſs here than in the tables of Siam; it is 2°, 10′, 30″; the equation of the moon's centre is 5°, 2′, 47″; her path, where it interſects that of the ſun, is ſuppoſed to make an angle with it of 4°, 30′, and the motions, both of the apogee and node, are determined very near to the truth.

16. ANOTHER ſet of tables, ſent from India by Father PATOUILLET, were received by M. DE L'ISLE, about the ſame time with thoſe of Chriſnabouram. They have not the name of any particular place affixed to them; but, as they contain a rule for determining the length of the day, which anſwers to the latitude of 16°, 16′, M. BAILLY thinks it probable that they come from Narſapour *.

THE precepts and examples, which accompany theſe tables, though without any immediate reference to them, are confined to the calculation of the eclipſes of the ſun and moon; but the tables themſelves extend to the motion of the planets, and very much reſemble thoſe of Chriſnabouram, except that they are given with leſs detail, and in a form much

* Aſt. Ind. p. 49, &c.

more enigmatical *. The epoch of the precepts, which M. BAILLY has evolved with great ingenuity, goes back no farther than the year 1569, at midnight, between the 17th and 18th of March. From this epoch, the places of the ſun and moon are computed, as in the tables of Siam, with the addition of an equation, which is indeed extremely ſingular. It reſembles that correction of the moon's motion, which was diſcovered by TYCHO, and which is called the annual equation, becauſe its quantity depends, not on the place of the moon, but on the place of the ſun, in the ecliptic. It is every where proportional to the inequality of the ſun's motion, and is nearly a tenth part of it. The tables of Narſapour make their annual equation only $\frac{1}{27}$ of the ſun's: but this is not their only miſtake; for they direct the equation to be added to the moon's longitude, when it ought to be ſubtracted from it, and *vice verſa*. Now, it is difficult to conceive from whence the laſt mentioned error has ariſen; for though it is not at all extraordinary, that the aſtronomers, who conſtructed theſe tables, ſhould miſtake the quantity of a ſmall equation, yet it is impoſſible, that the ſame obſervations, which informed them of its exiſtence, ſhould not have determined, whether it was to be added or ſubtracted. It would ſeem, therefore, that ſomething accidental muſt have occaſioned this error; but however that be, an inequality in the lunar motions, that is found in no ſyſtem with which the aſtronomers of India can have had any communication, is at leaſt a proof of the originality of their tables.

17. THE tables, and methods, of the Brahmins of Tirvalore, are, in many reſpects, more ſingular than any that have yet been

* THEY were explained, or rather decyphered by M. LE GENTIL in the Memoirs of the Academy of Sciences for 1784, p. 482, &c.; for they were not underſtood by the miſſionary who ſent them to Europe, nor probably by the Brahmins who inſtructed him. M. LE GENTIL thinks that they have the appearance of being copied from inſcriptions on ſtone. The minutes and ſeconds are ranged in rows under one another, not in vertical columns, and without any title to point out their meaning, or their connection. Theſe tables are publiſhed, Mem. Acad. *ibid.* p. 492, and Aſt. Ind. p. 414.

been defcribed *. The folar year is divided, according to them, into twelve unequal months, each of which is the time that the fun takes to move through one fign, or 30°, of the ecliptic. Thus, *Any*, or June, when the fun is in the third fign, and his motion floweft, confifts of 31^d, 36^h, 38′, and *Margagy*, or December, when he is in the ninth fign, and his motion quickeft, confifts only of 29^d, 20^h, 53′ †. The lengths of thefe months, expreffed in natural days, are contained in a table, which, therefore, involves in it the place of the fun's apogee, and the equation of his centre. The former feems to be 77° from the beginning of the zodiac, and the latter about 2°, 10′, nearly as in the preceding tables. In their calculations, they alfo employ an aftronomical day, which is different from the natural, being the time that the fun takes to move over one degree of the ecliptic; and of which days there are juft 360 in a year ‡.

18. THESE tables go far back into antiquity. Their epoch coincides with the famous era of the Calyougham, that is, with the beginning of the year 3102 before CHRIST. When the Brahmins of Tirvalore would calculate the place of the fun for a given time, they begin by reducing into days the interval between that time, and the commencement of the Calyougham, multiplying the years by 365^d, 6^h, 12′, 30″; and taking away 2^d, 3^h, 32′, 30″, the aftronomical epoch having begun that much later than the civil ‖. They next find, by means of certain divifions, when the year current began,

* TIRVALORE is a fmall town on the Coromandel coaft, about 12 G. miles weft of Negapatnam, in Lat. 10°, 44′, and eaft Long. from Greenwich, 79°, 42′, by RENNEL's map. From the obfervations of the Brahmins, M. LE GENTIL makes its Lat. to be 10°, 42′, 13″. (Mem. Acad. Scien. II. P. 184.) The meridian of Tirvalore nearly touches the weft fide of Ceylon, and therefore may be fuppofed to coincide with the firft meridian, as laid down by Father DU CHAMP. There is no reduction of Longitude employed in the methods of Tirvalore.

† Thefe are Indian hours, &c.

‡ Mem. Acad. des Scien. II. P. 187. Aft. Indienne, p. 76, &c.

‖ The Indian hours are here reduced to European.

gan, or how many days have elapsed since the beginning of it, and then, by the table of the duration of months, they reduce these days into astronomical months, days, &c. which is the same with the signs, degrees and minutes of the sun's longitude from the beginning of the zodiac. The sun's longitude, therefore, is found.

19. SOMEWHAT in the same manner, but by a rule still more artificial and ingenious, they deduce the place of the moon, at any given time, from her place at the beginning of the Calyougham *. This rule is so contrived, as to include at once the motions both of the moon and of her apogee, and depends on this principle, according to the very skilful interpretation of M. BAILLY, that, 1,600,894 days after the above mentioned epoch, the moon was in her apogee, and $7^s, 2^\circ, 0', 7''$, distant from the beginning of the zodiac; that after 12,372 days, the moon was again in her apogee, with her longitude increased, $9^s, 27^\circ, 48', 10''$; that in 3031 days more, the moon is again in her apogee, with $11^s, 7^\circ, 31', 1''$, more of longitude; and, lastly, that, after 248 days, she is again in her apogee, with $27^\circ, 44', 6''$, more of longitude. By means of the three former numbers, they find, how far, at any given time, the moon is advanced in this period of 248 days, and by a table, expressing how long the moon takes to pass through each degree of her orbit, during that period, they find how far she is then advanced in the zodiac †. This rule is strongly marked with all the peculiar characters of the Indian astronomy: It is remarkable for its accuracy, and still more for its ingenuity and refinement; but is not reduced withal, to its ultimate simplicity.

20. THE tables of Tirvalore, however, though they differ in form very much from those formerly described, agree with them

* Mem. Acad. des Scien. *ibid.* p. 229. Ast. Ind. p 84.

† M. LE GENTIL has given this table, Mem. Acad. *ibid.* p. 261.

them perfectly in many of their elements. They suppose the same length of the year, the same mean motions, and the same inequalities of the sun and moon, and they are adapted nearly to the same meridian *. But a circumstance in which they seem to differ materially from the rest is, the antiquity of the epoch from which they take their date, the year 3102 before the Christian era. We must, therefore, enquire, whether this epoch is real or fictitious, that is, whether it has been determined by actual observation, or has been calculated from the modern epochs of the other tables. For it may naturally be supposed, that the Brahmins, having made observations in later times, or having borrowed from the astronomical knowledge of other nations, have imagined to themselves a fictitious epoch, coinciciding with the celebrated era of the Calyougham, to which, through

* The accuracy of the geography of the Hindoos, is in no proportion to that of their astronomy, and, therefore, it is impossible that the identity of the meridians of their tables can be fully established. All that can be said, with certainty, is, that the difference between the meridians of the tables of Tirvalore and Siam is, at most, but inconsiderable, and may be only apparent, arising from an error in computing the difference of longitude between these places. The tables of Tirvalore are for Long. 79°, 42′; those of Siam for 82°, 34′; the difference is 2°, 52′, not more than may be ascribed to an error purely geographical.

As to the tables of Chrisnabouram, they contain a reduction, by which it appears, that the place where they are now used is 45′ of a degree east of the meridian for which they were originally constructed. This makes the latter meridian agree tolerably with that of Cape Comorin, which is in Long. 77°, 32′, 30″, and about half a degree west of Chrisnabouram. But this conclusion is uncertain; because, as M. Bailly has remarked, the tables sent from Chrisnabouram, and understood by Father du Champ to belong to that place, are not adapted to the latitude of it, but to one considerably greater, as appears from their rule for ascertaining the length of the day. (Ast. Ind. p. 33.)

The characters, too, by which the Brahmins distinguish their first meridian, are not perfectly consistent with one another. Sometimes it is described as bisecting Ceylon; and at other times, as touching it on the west side, or even as being as far west as Cape Comorin. Lanka, which is said to be a point in it, is understood, by Fath. du Champ, to be Ceylon. M. Bailly thinks that it is the lake Lanka, the source of the Gogra, placed by M. Rennel, as well as the middle of Ceylon, in Long. 80°, 42′; but, from a Hindoo map, in the Ayeen Akbery, vol. iii. p. 25. Lanka appears to be an island, which marks the intersection of the first meridian of the map, nearly that of Cape Comorin, with the equator; and is probably one of the Maldivy islands. See also a note in the Ayeen Akbery, *ibid.* p. 36.

through vanity or ſuperſtition, they have referred the places of the heavenly bodies, and have only calculated what they pretend that their anceſtors obſerved.

21. In doing this, however, the Brahmins muſt have furniſhed us with means, almoſt infallible, of detecting their impoſture. It is only for aſtronomy, in its moſt perfect ſtate, to go back to the diſtance of forty-ſix centuries, and to aſcertain the ſituation of the heavenly bodies at ſo remote a period. The modern aſtronomy of Europe, with all the accuracy that it derives from the teleſcope and the pendulum, could not venture on ſo difficult a taſk, were it not aſſiſted by the theory of gravitation, and had not the integral calculus, after an hundred years of almoſt continual improvement, been able, at laſt, to determine the diſturbances in our ſyſtem, which ariſe from the action of the planets on one another.

Unless the corrections for theſe diſturbances be taken into account, any ſyſtem of aſtronomical tables, however accurate at the time of its formation, and however diligently copied from the heavens, will be found leſs exact for every inſtant, either before or after that time, and will continually diverge more and more from the truth, both for future and paſt ages. Indeed, this will happen, not only from the neglect of theſe corrections, but alſo from the ſmall errors unavoidably committed, in determining the mean motions, which muſt accumulate with the time, and produce an effect that becomes every day more ſenſible, as we retire, on either ſide, from the inſtant of obſervation. For both theſe reaſons, it may be eſtabliſhed as a maxim, that, if there be given a ſyſtem of aſtronomical tables, founded on obſervations of an unknown date, that date may be found, by taking the time when the tables repreſent the celeſtial motions moſt exactly.

Here, therefore, we have a criterion, by which we are to judge of the pretenſions of the Indian aſtronomy to ſo great antiquity. It is true, that, in applying it, we muſt ſuppoſe our modern

modern aſtronomy, if not perfectly accurate, at leaſt ſo exact as to repreſent the celeſtial motions, without any ſenſible error, even for a period more remote than the Calyougham; and this, conſidering the multitude of obſervations on which our aſtronomy is founded, the great antiquity of ſome of thoſe obſervations, and the extreme accuracy of the reſt, together with the aſſiſtance derived from the theory of phyſical cauſes, may ſurely be aſſumed as a very reaſonable poſtulatum. We begin with the examination of the mean motions.

22. THE Brahmins place the beginning of their moveable zodiac, at the time of their epoch, 54° before the vernal equinox, or in the longitude of 10ˢ, 6°, according to our method of reckoning. Now, M. LE GENTIL brought with him a delineation of the Indian zodiac, from which the places of the ſtars in it may be aſcertained with tolerable exactneſs *. In particular, it appears, that Aldebaran, or the firſt ſtar of Taurus, is placed in the laſt degree of the fourth conſtellation, or 53°, 20′, diſtant from the beginning of the zodiac. Aldebaran was therefore 40′ before the point of the vernal equinox, according to the Indian aſtronomy, in the year 3102 before CHRIST. But the ſame ſtar, by the beſt modern obſervations, was, in the year 1750, in longitude, 2ˢ, 6°, 17′, 47″; and had it gone forward, according to the preſent rate of the preceſſion of the equinoxes, 50″⅓ annually, it muſt have been, at the era of the Calyougham, 1°, 32′, before the equinox. But this reſult is to be corrected, in conſequence of the inequality in the preceſſion, diſcovered by M. DE LA GRANGE †, by the addition of 1°, 45′, 22″, to the longitude of Aldebaran, which gives the longitude of that ſtar 13′ from the vernal equinox, at the time of the Calyougham, agreeing, within 53′, with the determination of the Indian aſtronomy ‡.

 THIS

* Mem. Acad. Scien. 1772, II. P. 214. Aſt. Ind. p. 129.

† Mem. Acad. de Berlin, 1782, p. 287. Aſt. Ind. p. 144.

‡ Aſt. Ind. p. 130.

THIS agreement is the more remarkable, that the Brahmins, by their own rules for computing the motion of the fixed ſtars, could not have aſſigned this place to Aldebaran for the beginning of the Calyougham, had they calculated it from a modern obſervation. For as they make the motion of the fixed ſtars too great by more than 3″ annually, if they had calculated backward from 1491, they would have placed the fixed ſtars leſs advanced by 4° or 5°, at their ancient epoch, than they have actually done. This argument carries with it a great deal of force; and even were it the only one we had to produce, it would render it, in a high degree, probable, that the Indian zodiac was as old as the Calyougham.

23. LET us next compare the places of the ſun and moon, for the beginning of the Calyougham, as deduced from the Indian and the modern aſtronomy. And, firſt, of the ſun, though, for a reaſon that will immediately appear, it is not to be conſidered as leading to any thing concluſive. M. BAILLY, from a compariſon of the tables of Tirvalore with thoſe of Chriſnabouram, has determined the epoch of the former to anſwer to midnight, between the 17th and 18th * of February of the year 3102 before CHRIST, at which time the ſun was juſt entering the moveable zodiac, and was therefore in longitude 10ˢ, 6°. M. BAILLY alſo thinks it reaſonable to ſuppoſe, that this was not the mean place of the ſun, as the nature of aſtronomical tables require, but the true place, differing from the mean, by the equation to the ſun's centre at that time †. This, it muſt be confeſſed, is the mark of greateſt unſkilfulneſs, that we meet with in the conſtruction of theſe tables. Suppoſing it, however, to be the caſe, the mean place of the ſun, at the time of

* Aſt. Ind. p. 110. The Brahmins, however, actually ſuppoſe the epoch to be 6 hours later, or at ſunriſe, on the ſame day. Their miſtake is diſcovered, as has been ſaid, by comparing the radical places in the different tables with one another.

† Aſt. Ind. p. 83.

of the epoch, comes out 10ˢ, 3°, 38′, 13″. Now, the mean longitude of the ſun, from DE LA CAILLE's tables, for the ſame time, is 10ˢ, 1°, 5′, 57″, ſuppoſing the preceſſion of the equinoxes to have been uniformly at the rate it is now, that is, 50″⅓ annually. But M. DE LA GRANGE has demonſtrated, that the preceſſion was leſs in former ages than in the preſent; and his formula gives 1°, 45′, 22″, to be added, on that account, to the ſun's longitude already found, which makes it 10ˢ, 2°, 51′, 19″, not more than 47′ from the radical place in the tables of Tirvalore. This agreement is near enough to afford a ſtrong proof of the reality of the ancient epoch, if it were not for the difficulty that remains about conſidering the ſun's place as the true, rather than the mean; and, for that reaſon, I am unwilling that any ſtreſs ſhould be laid upon this argument. The place of the moon is not liable to the ſame objection.

24. THE moon's mean place, for the beginning of the Calyougham, (that is, for midnight between the 17th and 18th of February 3102, A. C. at Benares), calculated from MAYER's tables, on the ſuppoſition that her motion has always been at the ſame rate as at the beginning of the preſent century, is 10ˢ, 0°, 51′, 16″ *. But, according to the ſame aſtronomer, the moon is ſubject to a ſmall, but uniform acceleration, ſuch, that her angular motion, in any one age, is 9″ greater than in the preceding, which, in an interval of 4801 years, muſt have amounted to 5°, 45′, 44″. This muſt be added to the preceding, to give the real mean place of the moon, at the aſtronomical epoch of the Calyougham, which is therefore 10ˢ, 6°, 37′. Now, the ſame, by the tables of Tirvalore, is 10ˢ, 6°, 0′; the difference is leſs than two-thirds of a degree, which, for ſo remote a period, and conſidering the acceleration of the moon's motion, for which no allowance

u 2 could

* Aſt. Ind. p. 142, &c. The firſt meridian is ſuppoſed to paſs through Benares; but even if it be ſuppoſed 3° farther weſt, the difference, which is here 37′, will be only increaſed to 42′.

could be made in an Indian calculation, is a degree of accuracy that nothing but actual obfervation could have produced.

25. To confirm this conclufion, M. BAILLY computes the place of the moon for the fame epoch, by all the tables to which the Indian aftronomers can be fuppofed to have ever had accefs *. He begins with the tables of PTOLEMY; and if, by help of them, we go back from the era of NABONASSAR, to the epoch of the Calyougham, taking into account the comparative length of the Egyptian and Indian years, together with the difference of meridians between Alexandria and Tirvalore, we fhall find the longitude of the fun 10°, 21′, 15″ greater, and that of the moon 11°, 52′, 7″ greater than has juft been found from the Indian tables †. At the fame time that this fhews, how difficult it is to go back, even for a lefs period than that of 3000 years, in an aftronomical computation, it affords a proof, altogether demonftrative, that the Indian aftronomy is not derived from that of PTOLEMY.

THE tables of ULUGH BEIG are more accurate than thofe of the Egyptian aftronomer. They were conftructed in a country not far from India, and but a few years earlier than 1491, the epoch of the tables of Chrifnabouram. Their date is July 4. at noon, 1437, at Samarcand; and yet they do not agree with the Indian tables, even at the above mentioned epoch of 1491 ‡. But, for the year 3102 before CHRIST, their difference from them, in the place of the fun, is 1°, 30′, and in that of the moon 6°; which, though much lefs than the former differences, are fufficient to fhow, that the tables of India are not borrowed from thofe of Tartary.

THE Arabians employed in their tables the mean motions of PTOLEMY; the Perfians did the fame, both in the more ancient tables of CHRYSOCOCCA, and the later ones of NASSIREDDIN ‖. It is

* Aft. Ind. p. 114.

† Ibid. p. 115.

‡ Ibid. p. 117.

‖ Ibid. p. 118.

is therefore certain, that the aſtronomy of the Brahmins is neither derived from that of the Greeks, the Arabians, the Perſians or the Tartars. This appeared ſo clear to CASSINI, though he had only examined the tables of Siam, and knew nothing of many of the great points which diſtinguiſh the Indian aſtronomy from that of all other nations, that he gives it as his opinion, that theſe tables are neither derived from the Perſian aſtronomy of CHRYSOCOCCA, nor from the Greek aſtronomy of PTOLEMY; the places they give at their epoch to the apogee of the ſun, and of the moon, and their equation for the ſun's centre, being very different from both *.

26. BUT, to return to what reſpects the moon's acceleration; it is plain, that tables, as ancient as thoſe of Tirvalore pretend to be, ought to make the mean motion of that planet much ſlower than it is at preſent. They do accordingly ſuppoſe, in the rule for computing the place of the moon, already deſcribed, that her motion for 4383 years, 94 days, reckoned in the moveable zodiac from the epoch of the Calyougham, is $7^s, 2^\circ, 0', 7''$, or $9^s, 7^\circ, 45', 1''$, when referred to the fixed point of the vernal equinox. Now, the mean motion for the ſame interval, taken from the tables of MAYER, is greater than this, by $2^\circ, 42', 4''$ †, which, though conformable, in general, to the notion of the moon's motion having been accelerated, falls, it muſt be confeſſed, greatly ſhort of the quantity which MAYER has aſſigned to that acceleration. This, however, is not true of all the tables; for the moon's motion in 4383 years, 94 days, taken from thoſe of Chriſnabouram, is $3^\circ, 2', 10''$ leſs than in the tables of Tirvalore ‡; from which it is reaſonable to conclude, with M. BAILLY, that the former are, in reality, more ancient than the latter, though they do not profeſs to be ſo: and hence, alſo, the tables of Chriſnabouram make

* Mem. Acad. Scien. tom. 8. p. 286.

† Aſt. Ind. p. 145.

‡ Ibid. p. 126.

make the moon's motion leſs than MAYER's, for the above mentioned interval, by 5°, 44′, 14″, which therefore is, according to them, the quantity of the acceleration.

27. Now, it is worthy of remark, that if the ſame be computed on MAYER's principles, that is, if we calculate how much the angular motion of the moon for 4383 years, 94 days, dated from the beginning of the Calyougham, muſt have been leſs than if her velocity had been all that time uniform, and the ſame as in the preſent century, we ſhall find it to be 5°, 43′, 7″, an arch which is only 1′, 7″, leſs than the former. The tables of Chriſnabouram, therefore, agree with thoſe of MAYER, when corrected by the acceleration within 1′, 7″, and that for a period of more than four thouſand years. From this remarkable coincidence, we may conclude, with the higheſt probability, that at leaſt one ſet of the obſervations, on which thoſe tables are founded, is not leſs ancient than the Calyougham; and though the poſſibility of their being ſome ages later than that epoch, is not abſolutely excluded, yet it may, by ſtrict mathematical reaſoning, be inferred, that they cannot have been later than 2000 years before the Chriſtian era *.

28. THIS

* THE reaſoning here referred to is the following: As the mean motions, in all aſtronomical tables, are determined by the compariſon of obſervations made at a great diſtance of time from one another; if x be the number of centuries between the beginning of the preſent, and the date of the more ancient obſervations, from which the moon's mean motion in the tables of Chriſnabouram is deduced; and if y denote the ſame for the more modern obſervations: then the quantity by which the moon's motion, during the interval $x-y$, falls ſhort of MAYER's, for the ſame interval, is $(x^2-y^2)9''$.

IF, therefore, m be the motion of the moon for a century in the laſt mentioned tables, $m(x-y)-9''(x^2-y^2)$ will be the mean motion for the interval $x-y$ in the tables of Chriſnabouram. If, then, a be any other interval, as that of 43.83 centuries, the mean motion aſſigned to it, in theſe laſt tables, by the rule of proportion, will be $\frac{ma(x-y)-9''a(x^2-y^2)}{x-y} = ma-9a(x+y)$. Let this motion, actually taken from the tables

28. THIS laſt is one of the few coincidences between the aſtronomy of India and of Europe, which their ingenious hiſtorian has left for others to obſerve. Indeed, ſince he wrote, every argument, founded on the moon's acceleration, has become more worthy of attention, and more concluſive. For that acceleration is no longer a mere empyrical equation, introduced to reconcile the ancient obſervations with the modern, nor a fact that can only be accounted for by hypothetical cauſes, ſuch as the reſiſtance of the ether, or the time neceſſary for the tranſmiſſion of gravity; it is a phenomenon, which M. DE LA PLACE has *, with great ability, deduced from the principle of univerſal gravitation, and ſhewn to be neceſſarily connected with the changes in the eccentricity of the earth's orbit, diſcovered by M. DE LA GRANGE; ſo that the acceleration of the moon is indirectly produced by the action of the planets, which alternately increaſing and diminiſhing the ſaid eccentricity, ſubjects the moon to different degrees of that force by which the ſun diſturbs the time of her revolution round the earth. It is therefore a periodical inequality, by which the moon's motion, in the courſe of ages, will be as much retarded as accelerated; but its changes are ſo ſlow, that her motion has been conſtantly accelerated, even for a longer period than that to which the obſervations of India extend.

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bles be $= na$, then $ma - na = 9a(x+y)$, or $x+y = \frac{m-n}{g} = 52.19$, in the preſent caſe. It is certain, therefore, that whatever ſuppoſition be made with reſpect to the interval between x and y, their ſum muſt always be the ſame, and muſt amount to 5219 years. But that, that interval may be long enough to give the mean motions with exactneſs, it can ſcarcely be ſuppoſed leſs than 2000 years; and, in that caſe, $x = 3609$ years, which therefore is its leaſt value. But if 3609 be reckoned back from 1700, it goes up to 1909 years before CHRIST, nearly, as has been ſaid.

IT muſt be remembered, that what is here inveſtigated is the limit, or the moſt modern date poſſible to be aſſigned to the obſervations in queſtion. The ſuppoſition that $x-y = a$, is the moſt probable of all, and it gives $x = 4801$, which correſponds to the beginning of the Calyougham.

* Mem. Acad. des Scien. 1786, p. 235, &c.

A FORMULA for computing the quantity of this inequality, has been given by M. DE LA PLACE, which, though only an approximation, being derived from theory, is more accurate than that which MAYER deduced entirely from obſervation * ; and if it be taken inſtead of MAYER's, which laſt, on account of its ſimplicity, I have employed in the preceding calculations, it will give a quantity ſomewhat different, though not ſuch as to affect the general reſult. It makes the acceleration for 4383 years, dated from the beginning of the Calyougham, to be greater by 17′, 39″, than was found from MAYER's rule, and greater conſequently by 16′. 32″, than was deduced from the tables of Chriſnabouram. It is plain, that this coincidence is ſtill near enough to leave the argument, that is founded on it, in poſſeſſion of all its force, and to afford a ſtrong confirmation of the accuracy of the theory, and the authenticity of the tables.

THAT obſervations made in India, when all Europe was barbarous or uninhabited, and inveſtigations into the moſt ſubtle effects of gravitation made in Europe, near five thouſand years afterwards, ſhould thus come in mutual ſupport of one another, is perhaps the moſt ſtriking example of the progreſs and viciſſitude of ſcience, which the hiſtory of mankind has yet exhibited.

29. THIS, however, is not the only inſtance of the ſame kind that will occur, if, from examining the radical places and mean motions in the Indian aſtronomy, we proceed to conſider ſome other of its elements, ſuch as, the length of the year, the inequality of the ſun's motion, and the obliquity of the ecliptic, and compare them with the concluſions deduced, from the theory of gravity, by M. DE LA GRANGE. To that geometer, phyſical aſtronomy is indebted for one of the moſt beautiful of its diſcoveries, *viz.* That all the variations in our ſyſtem are periodical; ſo that though every thing, almoſt without exception,

* Mem. Acad. des Scien. 1786, p. 260.

tion, be ſubject to change, it will, after a certain interval, return to the ſame ſtate in which it is at preſent, and leave no room for the introduction of diſorder, or of any irregularity that might conſtantly increaſe. Many of theſe periods, however, are of vaſt duration. A great number of ages, for inſtance, muſt elapſe before the year be again exactly of the ſame length, or the ſun's equation of the ſame magnitude as at preſent *. An aſtronomy, therefore, which profeſſes to be ſo ancient as the Indian, ought to differ conſiderably from ours in many of its elements. If indeed theſe differences are irregular, they are the effects of chance, and muſt be accounted errors; but if they obſerve the laws, which theory informs us that the variations in our ſyſtem do actually obſerve, they muſt be held as the moſt undoubted marks of authenticity. We are to examine, as M. BAILLY has done, which of theſe takes place in the caſe before us †.

30. THE tables of Tirvalore, which, as we have ſeen, refer their date to the beginning of the Calyougham, make the ſyderial year to conſiſt of 365^d, 6^h, $12'$, $30''$; and therefore the tropical of 365^d, 5^h, $50'$, $35''$, which is $1'$, $46''$, longer than that of DE LA CAILLE ‡. Now, the tropical year was in reality longer at that time than it is at preſent; for though the ſiderial year, or the time which the earth takes to return from one point of ſpace to the ſame point again, is always of the ſame magnitude, yet the tropical year being affected by the preceſſion of the equinoxes, is variable by a ſmall quantity, which never can exceed $3'$, $40''$, and which is ſubject to ſlow, and unequal alternations of diminution and increaſe. A theorem, expreſſing the law and the quantity of this variation, has been inveſtigated by M. DE LA GRANGE, in the excellent Memoir

* Mem. de l'Acad. de Berlin, 1782, p. 170, &c.

† Aſt. Ind. p. 160, &c.

‡ Supra, § 18. and 10.

moir already mentioned *; and it makes the year 3102 before CHRIST, 40″$\frac{1}{7}$ longer than the year at the beginning of the present century †. The year in the tables of Tirvalore is therefore too great by 1′, 5″$\frac{1}{2}$.

31. BUT the determination of the year is always from a comparison of observations made at a considerable interval from one another; and, even to produce a degree of accuracy much less than what we see belongs to the tables of Tirvalore, that interval must have been of several ages. Now, says M. BAILLY, if we suppose these observations to have been made in that period of 2400 years, immediately preceding the Calyougham, to which the Brahmins often refer; and if we also suppose the inequality of the precession of the equinoxes, to increase as we go back, in proportion to the square of the times, we shall find, that, at the middle of this period, or 1200 years before the beginning of the Calyougham, the length of the year was 365^d, 5^h, 50′, 41″, almost precisely as in the tables of Tirvalore. And hence it is natural to conclude, that this determination of the solar year is as ancient as the year 1200 before the Calyougham, or 4300 before the Christian era ‡.

32. IN this reasoning, however, it seems impossible to acquiesce; and M. BAILLY himself does not appear to have relied on it with much confidence ‖. We are not at liberty to suppose, that the precession of the equinoxes increases in the ratio above mentioned, or, which is the same, that the equinoctial points go back with a motion equably retarded. If, by M. DE GRANGE's formula, we trace back, step by step, the variation of the solar year, we shall find, that about the beginning of the Calyougham, it had nearly attained the extreme point of one

* Mem. Acad. Berlin, 1782. p. 289.

† Ast. Ind. p. 160.

‡ Ibid. p. 161.

‖ HE says, "Sans doute il ne peut résulter de ce calcul qu'un apperçu."

one of thoſe vibrations, which many centuries are required to complete; and that the year was then longer than it has ever been ſince, or than it had been for many ages before. It was $40''\frac{1}{2}$ longer than it is at preſent; but, at the year 5500 before CHRIST, it was only 29″ longer than at preſent, inſtead of 2′, 50″, which is the reſult of M. BAILLY's ſuppoſition. During all the intervening period of 2400 years, the variation of the year was between theſe two quantities; and we cannot therefore, by any admiſſible ſuppoſition, reduce the error of the tables to leſs than 1′, 5″. The ſmallneſs of this error, though extremely favourable to the antiquity, as well as the accuracy of the Indian aſtronomy, is a circumſtance from which a more preciſe concluſion can hardly be deduced.

33. THE equation of the ſun's centre is an element in the Indian aſtronomy, which has a more unequivocal appearance of belonging to an earlier period than the Calyougham. The maximum of that equation is fixed, in theſe tables, at 2°, 10′, 32″. It is at preſent, according to M. DE LA CAILLE, 1°, $55'\frac{1}{2}$, that is, 15′ leſs than with the Brahmins. Now, M. DE LA GRANGE has ſhewn, that the ſun's equation, together with the eccentricity of the earth's orbit, on which it depends, is ſubject to alternate diminution and increaſe, and accordingly has been diminiſhing for many ages. In the year 3102 before our era, that equation was 2°, 6′, $28''\frac{1}{2}$; leſs, only by 4′, than in the tables of the Brahmins. But if we ſuppoſe the Indian aſtronomy to be founded on obſervations that preceded the Calyougham, the determination of this equation will be found to be ſtill more exact. Twelve hundred years before the commencement of that period, or about 4300 years before our era, it appears, by computing from M. DE LA GRANGE's formula, that the equation of the ſun's centre was actually 2°, 8′, 16″; ſo that if the Indian aſtronomy be as old as that period, its error with reſpect to this equation is but of 2′ *.

* Aſt. Ind. p. 163.

34. THE obliquity of the ecliptic is another element in which the Indian aſtronomy and the European do not agree, but where their difference is exactly ſuch as the high antiquity of the former is found to require. The Brahmins make the obliquity of the ecliptic 24°. Now, M. DE LA GRANGE's formula for the variation of the obliquity *, gives 22′, 32″, to be added to its obliquity in 1700, that is, to 23°, 28′, 41″, in order to have that which took place in the year 3102 before our era. This gives us 23°, 51′, 13″, which is 8′, 47″, ſhort of the determination of the Indian aſtronomers. But if we ſuppoſe, as in the caſe of the ſun's equation, that the obſervations on which this determination is founded, were made 1200 years before the Calyougham, we ſhall find that the obliquity of the ecliptic was 23°, 57′, 45″, and that the error of the tables did not much exceed 2′ †.

35. THUS, do the meaſures which the Brahmins aſſign to theſe three quantities, the length of the tropical year, the equation of the ſun's centre, and the obliquity of the ecliptic, all agree in referring the epoch of their determination to the year 3102 before our era, or to a period ſtill more ancient. This coincidence in three elements, altogether independent of one another, cannot be the effect of chance. The difference, with reſpect to each of them, between their aſtronomy and ours, might ſingly perhaps be aſcribed to inaccuracy; but that three errors, which chance had introduced, ſhould be all of ſuch magnitudes, as to ſuit exactly the ſame hypotheſis concerning their origin, is hardly to be conceived. Yet there is no other alternative, but to admit this very improbable ſuppoſition, or to acknowledge that the Indian aſtronomy is as ancient as one, or other of the periods above mentioned.

36. THIS concluſion would receive great additional confirmation, could we follow M. BAILLY in his analyſis of the aſtronomy

* Mem. Acad. Berlin, 1782, p. 287.

† Aſt. Ind. p. 165.

nomy of the planets, contained in the tables of Chriſnabouram *; but the length to which this *paper* is already extended, will allow only a few of the moſt remarkable particulars to be ſelected.

In theſe tables, which are for the epoch 1491, the mean motions are given with conſiderable accuracy, but without an appearance of being taken from Ptolemy, or any of the aſtronomers already mentioned. Two inequalities, called the *ſchigram* and the *manda*, are alſo diſtinguiſhed in each of the planets, both ſuperior and inferior †. The firſt of theſe is the ſame with that which we call the parallax of the earth's orbit, or the apparent inequality of a planet, which ariſes not from its own motion, but from that of the obſerver; but whether it is aſcribed, in the Indian aſtronomy, to its true cauſe, or to the motion of the planet in an epicycle, is a queſtion about which the tables give no direct information. The magnitude, however, of this equation is aſſigned, for each of the planets, with no ſmall exactneſs, and is varied, in the different points of its orbit, by a law which approaches very near to the truth.

The other inequality coincides with that of the planet's centre, or that which ariſes from the eccentricity of its orbit, and it is given near the truth for all the planets, except Mercury, by which, as is no wonder, the firſt aſtronomers were, every where, greatly deceived. Of this inequality, it is ſuppoſed, juſt as in the caſes of the ſun and moon, that it is always as the ſine of the planet's diſtance from the point of its ſloweſt motion, or from what we call its aphelion, and is conſequently greateſt at 90° from that point.

It were to be wiſhed that we knew the etymology of the names which are given to theſe inequalities, as it might explain the theory which guided the authors of the tables. The titles of our aſtronomical tables, the terms *aphelion*, *heliocentric* or

* Aſt. Ind. p. 173, &c.

† Ibid. p. 177.

or *geocentric place*, &c. would difcover the leading ideas of the Copernican fyftem, were no other defcription of it preferved.

37. In the manner of applying thefe two inequalities, to correct the mean place of a planet, the rules of this aftronomy are altogether fingular. In the cafe of a fuperior planet, they do not make ufe of the mean anomaly, as the argument for finding out the equation *manda*, but of that anomaly, when corrected firft by half the equation *fchigram*, and afterwards by half the equation *manda* *. By the equation of the centre, obtained with this argument, the mean longitude of the planet is corrected, and its true heliocentric place confequently found, to which there is again applied the parallax of the annual orbit, that the geocentric place may be obtained. The only difficulty here, is in the method of taking out from the tables the equation to the centre. It is evidently meant for avoiding fome inaccuracy, which was apprehended from a more direct method of calculation, but of which, even after the ingenious remarks of M. Bailly, it feems impoffible to give any clear and fatisfactory account.

38. The manner of calculating the places of the inferior planets has a great refemblance to the former; with this difference, however, that the equation *manda*, or of the centre, is applied to correct, not the mean place of the planet, but the mean place of the fun; and to this laft, when fo corrected, is applied the equation *fchigram*, which involves the planet's elongation from the fun, and gives its geocentric place †. This neceffarily implies, that the centre, about which the inferior planets revolve, has the fame apparent mean motion with the fun: but whether it be a point really different from the fun, or the fame; and, if the fame, whether it be in motion or at reft, are left entirely undetermined, and we know not, whether, in the aftronomy of India, we have here difcovered a refemblance

* Aft. Ind. p. 194.

† Ibid. p. 199, &c.

blance to the Ptolemaic, the Tychonic, or the Copernican ſyſtem.

39. These tables, though their radical places are for the year 1491 of our era, have an obvious reference to the great epoch of the Calyougham. For if we calculate the places of the planets from them, for the beginning of the aſtronomical year, at that epoch, we find them all in conjunction with the ſun in the beginning of the moveable zodiac, their common longitude being 10ˢ, 6° *. According to our tables, there was, at that time, a conjunction of all the planets, except Venus, with the ſun; but they were, by no means, ſo near to one another as the Indian aſtronomy repreſents. It is true, that the exact time of a conjunction cannot be determined by direct obſervation: but this does not amount to an entire vindication of the tables; and there is reaſon to ſuſpect, that ſome ſuperſtitious notions, concerning the beginning of the Calyougham, and the ſigns by which nature muſt have diſtinguiſhed ſo great an epoch, has, in this inſtance at leaſt, perverted the aſtronomy of the Brahmins. There are, however, ſome coincidences between this part of their aſtronomy, and the theory of gravity, which muſt not be forgotten.

40. The firſt of theſe reſpects the aphelion of Jupiter, which, in the tables, is ſuppoſed to have a retrograde motion of 15° in 200,000 years †, and to have been, at the epoch of 1491, in longitude 5ˢ, 21°, 40′, 20″, from the beginning of the zodiac. It follows, therefore, that in the year 3102 before Christ, the longitude of Jupiter's aphelion was 3ˢ, 27°, 0′, reckoned from the equinox. Now, the ſame, computed from M. de la Lande's tables, is only 3ˢ, 16°, 48′, 58″; ſo that there would ſeem to be an error of more than 10° in the tables of the Brahmins. But, if it be conſidered, that Jupiter's orbit is

* Aſt. Ind. p. 181.

† Ibid. p. 184. § 13.

is ſubject to great diſturbances, from the action of Saturn, which M. DE LA LANDE does not profeſs to have taken into account, we will be inclined to appeal once more to M. DE LA GRANGE's formulas, before we paſs ſentence againſt the Indian aſtronomy *.

FROM one of theſe formulas, we find, that the true place of the aphelion of Jupiter, at the time above mentioned, was 3^s, 26°, 50′, 40″, which is but 10′, 40″, different from the tables of Chriſnabouram. The French and Indian tables are therefore both of them exact, and only differ becauſe they are adapted to ages near five thouſand years diſtant from one another.

41. THE equation of Saturn's centre is an inſtance of the ſame kind. That equation, at preſent, is, according to M. DE LA LANDE, 6°, 23′, 19″; and hence, by means of one of the formulas above mentioned, M. BAILLY calculates, that, 3102 years before CHRIST, it was 7°, 41′, 22″ †. The tables of the Brahmins make it 7°, 39′, 44″, which is leſs only by 1′, 38″, than the preeeding equation, though greater than that of the preſent century by 1°, 16′, 25″.

42. M. BAILLY remarks, that the equations for the other planets are not given with equal accuracy, and afford no more ſuch inſtances as the former. But it is curious to obſerve, that new reſearches into the effects of gravitation, have diſcovered new coincidences of the ſame kind; and that the two great geometers, who have ſhared between them the glory of perfecting the *theory of diſturbing forces*, have each contributed his part to eſtabliſh the antiquity of the Indian aſtronomy. Since the publication of M. BAILLY's work, two other inſtances of an exact agreement, between the elements of theſe tables, and the concluſions deduced from the theory of gravity, have been obſerved, and communicated to him by M. DE LA PLACE, in a letter, inſerted in the *Journal des Savans*.

IN

* Mem. Acad. Berlin. 1782, p. 246. Aſt. Ind. p. 186.

† Aſt. Ind. p. 188.

In seeking for the cause of the secular equations, which modern astronomers have found it necessary to apply to the mean motion of Jupiter and Saturn, M. de la Place has discovered, that there are inequalities belonging to both these planets, arising from their mutual action on one another, which have long periods, one of them no less than 877 years; so that the mean motion must appear different, if it be determined from observations made in different parts of those periods. "Now, "I find," says he, "by my theory, that at the Indian epoch "of 3102 years before Christ, the apparent and annual "mean motion of Saturn was 12°, 13′, 14″, and the Indian "tables make it 12°, 13′, 13″.

"In like manner, I find, that the annual and apparent mean "motion of Jupiter at that epoch was 30°, 20′, 42″, precisely "as in the Indian astronomy *."

43. Thus have we enumerated no less than nine astronomical elements †, to which the tables of India assign such values as do, by no means, belong to them in these later ages, but such as the theory of gravity proves to have belonged to them three thousand years before the Christian era. At that time, therefore, or in the ages preceding it, the observations must have been made from which these elements were deduced. For it is abundantly evident, that the Brahmins of later times, however willing they might be to adapt their tables to so remarkable an epoch as the Calyougham, could never think of doing so, by substituting, instead of quantities which they had observed, others which they had no reason to believe had ever existed. The elements in question are precisely what these

 astronomers

* Esprit des Journeaux, Nov. 1787. p. 80.

† The inequality of the precession of the equinoxes, (§ 22.); the acceleration of the moon; the length of the solar year; the equation of the sun's centre; the obliquity of the ecliptic; the place of Jupiter's aphelion; the equation of Saturn's centre; and the inequalities in the mean motion of both these planets.

aſtronomers muſt have ſuppoſed invariable, and of which, had they ſuppoſed them to change, they had no rules to go by for aſcertaining the variations; ſince, to the diſcovery of theſe rules is required, not only all the perfection to which aſtronomy is, at this day, brought in Europe, but all that which the ſciences of motion and of extenſion have likewiſe attained. It is no leſs clear, that theſe coincidences are not the work of accident; for it will ſcarcely be ſuppoſed that chance has adjuſted the errors of the Indian aſtronomy with ſuch ſingular felicity, that obſervers, who could not diſcover the true ſtate of the heavens, at the age in which they lived, have ſucceeded in deſcribing one which took place ſeveral thouſand years before they were born.

44. THE argument, however, which regards the originality of theſe tables, is, in ſome meaſure, incomplete, till we have conſidered the geometrical principles which have been employed in their conſtruction. For it is not impoſſible, that when ſeen connected by thoſe principles, and united into general theorems, they may be found to have relations to the Greek aſtronomy, which did not appear, when the parts were examined ſingly. On this ſubject, therefore, I am now to offer a few obſervations.

45. THE rules by which the phenomena of eclipſes are deduced from the places of the ſun and moon, have the moſt immediate reference to geometry; and of theſe rules, as found among the Brahmins of Tirvalore, M. LE GENTIL has given a full account, in the Memoir that has been ſo often quoted. We have alſo an account of the method of calculation uſed at Chriſnabouram by Father DU CHAMP *.

IT is a neceſſary preparation, in both of theſe, to find the time of the ſun's continuance above the horizon, at the place and the day for which the calculation of an eclipſe is made, and the rule by which the Brahmins reſolve this problem, is extremely ſimple and

* Aſt. Ind. p. 355, &c.

and ingenious. At the place for which they calculate, they obſerve the ſhadow of a gnomon on the day of the equinox, at noon, when the ſun, as they expreſs it, is in the middle of the world. The height of the gnomon is divided into 720 equal parts, in which parts the length of the ſhadow is alſo meaſured. One third of this meaſure is the number of minutes by which the day, at the end of the firſt month after the equinox, exceeds twelve hours; four-fifths of this exceſs is the increaſe of the day during the ſecond month; and one third of it is the increaſe of the day, during the third month *.

46. IT is plain, that this rule involves the ſuppoſition, that, when the ſun's declination is given, the ſame ratio every where exiſts between the arch which meaſures the increaſe of the day at any place, and the tangent of the latitude; for that tangent is the quotient which ariſes from dividing the length of the ſhadow by the height of the gnomon. Now, this is not ſtrictly true; for ſuch a ratio only ſubſiſts between the chord of the arch, and the tangent above mentioned. The rule is, therefore, but an approximation to the truth, as it neceſſarily ſuppoſes the arch in queſtion to be ſo ſmall as to coincide nearly with its chord. This ſuppoſition holds only of places in low latitudes; and the rule which is founded on it, though it may ſafely be applied in countries between the tropics, in thoſe that are more remote from the equator, would lead into errors too conſiderable to eſcape obſervation †.

 As

* Mem. Acad. des Scien. II. P. 175.

† To judge of the accuracy of this approximation, ſuppoſe O to be the obliquity of the ecliptic, and x the exceſs of the ſemidiurnal arch, on the longeſt day, above an arch of 90°, then $\mathit{fin}.\, x = \tan. O \times \tan. lat.$ But if G be the height of a gnomon, and S the length of its ſhadow on the equinoctial day, $\frac{S}{G} = \tan. lat.$ and $\mathit{fin}.\, x = \tan. O \times \frac{S}{G}$.

Therefore $x = \tan. O \times \frac{S}{G} + \frac{\tan. O^3 \times S^3}{6G^3} + \frac{\tan. O^5 \times S^5}{24G^5}$ + &c. or in minutes of time,

As some of the former rules, therefore, have served to fix the time, so does this, in some measure, to ascertain the place of its invention. It is the simplification of a general rule, adapted to the circumstances of the torrid zone, and suggested to the astronomers of Hindostan by their peculiar situation. It implies the knowledge of the circles of the sphere, and of spherical trigonometry, and perhaps argues a greater progress in mathematical reasoning, than a theorem that was perfectly accurate would have done. The first geometers must naturally have dreaded nothing so much as any abatement in the rigour of their demonstrations, because they would see no limits to the error and uncertainty, in which they might, by that means, be involved. It was long before the mathematicians of Greece understood how to set bounds to such errors, and to ascertain their utmost extent, whether on the side of excess or defect; in this art, they appear to have received the first lessons so late as the age of ARCHIMEDES.

47. THE

time, reckoned after the Indian manner, $x = 572.957\,(tan.O \times \frac{S}{G} + tan.O^3 \times \frac{S^3}{6G^3} + \&c.)$

IF $O = 24°$, then $tan.O = .4452$, and the first term of this formula gives $x = 572.957 \times \frac{.4452S}{G} = \frac{255S}{G}$, which is the same with the rule of the Brahmins.

FOR that rule, reduced into a formula, is $2x = \frac{720S}{G}\left(\frac{1}{3} + \frac{4}{15} + \frac{1}{9}\right) = \frac{512S}{G}$, or $x = \frac{256S}{G}$.

THEY have therefore computed the coefficient of $\frac{S}{G}$ with sufficient accuracy; the error produced by the omission of the rest of the terms of the series will not exceed 1′, even at the tropics, but, beyond them, it increases fast, and, in the latitude of 45°, would amount to 8′.

47. The Brahmins having thus obtained the variations of the length of the day, at any place, or what we call the afcenfional differences, apply them likewife to another purpofe. As they find it neceffary to know the point of the ecliptic, which is on the horizon, at the time when an eclipfe happens, they have calculated a table of the right afcenfions of the points of the ecliptic in time, to which they apply the afcenfional differences for the place in queftion, in order to have the time which each of the figns takes to defcend below the horizon of that place *. This is exactly the method, as is well known, which the moft fkilful aftronomer, in like circumftances, would purfue. Their table of the differences of right afcenfion is but for a few points in the ecliptic, *viz.* the beginning of each fign, and is only carried to minutes of time, or tenths of a degree. It is calculated, however, fo far as it goes, with perfect accuracy, and it fuppofes the obliquity of the ecliptic, as before, to be twenty-four degrees.

Such calculations could not be made without fpherical trigonometry, or fome method equivalent to it. If, indeed, we would allow the leaft fkill poffible to the authors of thefe tables, we may fuppofe, that the arches were meafured on the circles of a large globe, or armillary fphere, fuch as we know to have been one of the firft inftruments of the Egyptian and Greek aftronomers. But there are fome of the tables where the arches are put down true to feconds, a degree of accuracy which a mechanical method can fcarcely have afforded.

48. In another part of the calculation of eclipfes, a direct application is made of one of the moft remarkable propofitions in geometry. In order to have the femiduration of a folar eclipfe, they fubtract from the fquare of the fum of the femidiameters of the fun and moon, the fquare of a certain line, which is a perpendicular from the centre of the fun on the path of the moon; and from the remainder, they extract the

* Acad. des Scien. 1772, II. P. 205.

the ſquare root, which is the meaſure of the ſemiduration *. The ſame thing is practiſed in lunar eclipſes †. Theſe operations are all founded on a very diſtinct conception of what happens in the caſe of an eclipſe, and on the knowledge of this theorem, that, in a right-angled triangle, the ſquare on the hypothenuſe is equal to the ſquares on the other two ſides. It is curious to find the theorem of PYTHAGORAS in India, where, for aught we know, it may have been diſcovered, and from whence that philoſopher may have derived ſome of the ſolid, as well as the viſionary ſpeculations, with which he delighted to inſtruct or amuſe his diſciples.

49. WE have mentioned the uſe that is made of the ſemidiameters of the ſun and moon in theſe calculations, and the method of aſcertaining them, is deſerving of attention. For the ſun's apparent diameter, they take four-ninths of his diurnal motion, and for the moon's diameter, one twenty-fifth of her diurnal motion. In an eclipſe, they ſuppoſe the ſection of the ſhadow of the earth, at the diſtance of the moon, to have a diameter five times that of the moon; and in all this, there is conſiderable accuracy, as well as great ſimplicity. The apparent diameters of the ſun and moon, increaſe and diminiſh with their angular velocities; and though there be a miſtake in ſuppoſing, that they do ſo exactly in the ſame proportion, it is one which, without teleſcopes and micrometers, cannot eaſily be obſerved. The ſection of the earth's ſhadow, likewiſe, if the ſun's apparent diameter be given, increaſes as the moon's increaſes, or as her diſtance from the earth diminiſhes, and nearly enough in the ſame ratio to juſtify the rule which is here laid down.

50. THE hiſtorian of the Academy of Sciences, in giving an account of M. LE GENTIL's Memoir, has juſtly obſerved, that the

* Mem. Acad. des Scien. 1772, II. P. 259.

† Ibid. 241.

the rule defcribed in it, for finding the difference between the true and apparent conjunction, at the time of a folar eclipfe, contains the calculation of the moon's parallax, but fubftitutes the parallax in right afcenfion for the parallax in longitude *; an error which the authors of this aftronomy would probably have avoided, had they derived their knowledge from the writings of PTOLEMY. From this fuppofed parallax in longitude, they next derive the parallax in latitude, where we may obferve an application of the doctrine of fimilar triangles; for they fuppofe the firft of thefe to be to the laft in the conftant ratio of 25 to 2, or nearly as the radius to the tangent of the inclination of the moon's orbit to the plane of the ecliptic. We have here, therefore, the application of another geometrical theorem, and that too proceeding on the fuppofition, that a fmall portion of the fphere, on each fide of the point which the fun occupies at the middle of the eclipfe, may be held to coincide with a plane touching it in that point.

51. THE refult which the Brahmins thus obtain will be allowed to have great accuracy, if it be confidered how fimple their rules are, and how long it muft be fince their tables were corrected by obfervations. In two eclipfes of the moon, calculated in India by their method, and likewife obferved there by M. LE GENTIL, the error, in neither cafe, exceeded 23′ of time, (correfponding to one of 13′ of a degree, in the place of the moon); and in the duration and magnitude of the eclipfe, their calculation came ftill nearer to the truth †.

52. SINCE

* Hift. Acad. II. P. 109. Ibid. Mem. 253,—256.

† IN the language, however, of their rules, we may trace fome marks of a fabulous and ignorant age, from which indeed even the aftronomy of Europe is not altogether free. The place of the moon's afcending node, is with them *the place of the Dragon* or *the Serpent*; the moon's diftance from the node, is literally tranflated by M. LE GENTIL, la

52. SINCE an inequality was firſt obſerved in the motions of the ſun or moon, the diſcovery of the law which it follows, and the method of determining the quantity of it, in the different points of their orbits, has been a problem of the greateſt importance; and it is curious to inquire, in what manner the aſtronomers of India have proceeded to reſolve it. For this purpoſe, we muſt examine the tables of the *chaiaa*, or equations of the centre for the ſun and moon, and of the *manda*, or equations of the centre for the planets. With reſpect to the firſt, as contained in the tables of Siam, M. CASSINI obſerved, that the equations followed the ratio of the ſines of the mean diſtances from the apogee; but as they were calculated only for a few points of the orbit, it could not be known with what degree of exactneſs this law was obſerved. Here, however, the tables of Chriſnabouram remove the uncertainty, as they give the equation of the centre for every degree of the mean motion, and make it nearly as the ſine of the diſtance from the apogee.

THEY do ſo, however, only nearly; and it will be found on trial, that there is, in the numbers of the table, a ſmall, but regular variation from this law, which is greateſt when the argument is 30°, though even there it does not amount to a minute. The ſun's equation, for inſtance, which, when greateſt, or when the argument is 90°, is, by theſe tables, 2°, 10′, 32″, ſhould be, when the argument is 30°, juſt the half of this, or 1°, 5′, 16″, did the numbers in the table follow exactly the ratio

la lune offenſée du dragon. Whether it be that we have borrowed theſe abſurdities from India, along with aſtrology, or if the popular theory of eclipſes has, at firſt, been every where the ſame, the moon's node is alſo known with us by the name of the *cauda draconis.* In general, however, the ſignification of the terms in theſe rules, ſo far as we know it, is more rational. In one of them we may remark conſiderable refinement; *ayanangſam,* which is the name for the reduction made on the ſun's longitude, on account of the preceſſion of the equinoxes, is compounded from *ayanam,* a *courſe,* and *angſam,* an *atom.* Mem. Acad. II. P. 251. The equinox is almoſt the only point not diſtinguiſhed by a viſible object, of which the *courſe* or motion is computed in this aſtronomy.

ratio of the ſines of the argument. It is, however, 1°, 6′, 3″; and this exceſs of 47″ cannot have ariſen from any miſtake about the ratio of the ſine of 30° to that of 90°, which is ſhewn to be that of 1 to 2, by a propoſition in geometry * much too ſimple to have been unknown to the authors of theſe tables. The rule, therefore, of the equations, being proportional exactly to the ſines of the argument, is not what was followed, or intended to be followed, in the calculation of them. The differences, alſo, between the numbers computed by that rule, and thoſe in the tables, are perfectly regular, decreaſing from the point of 30°, both ways toward the beginning and end of the quadrant, where they vaniſh altogether.

These obſervations apply alſo to the tables of Narſapur †, and to the moon's equations, as well as to the ſun's, with a circumſtance, however, which is not eaſily accounted for, *viz.* that the differences between the numbers calculated by M. Cassini's rule, and thoſe in the tables, are not greater in the caſe of the moon than of the ſun, though the equation of the latter be more than double that of the former. They apply alſo to the tables *manda* of the planets, where the equations are greater than the ratio of the ſines of their arguments requires, the exceſs being greateſt at 30°, and amounting to ſome minutes in the equations of Saturn, Jupiter and Mars, in which laſt it is greateſt of all.

53. Though, for theſe reaſons, it is plain, that the rule of M. Cassini is not the ſame with that of the Brahmins, it certainly includes the greater part of it; and if the latter, whatever it may have been, were expreſſed in a ſeries, according to the methods of the modern analyſis, the former would be the firſt term of that ſeries. We are not, however, much advanced in our inquiry in conſequence of this remark; for the firſt terms of all the ſeries, which can, on any hypotheſis, expreſs

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* Euc. Lib. IV. Prop. 15.

† See theſe tables, Aſt. Ind. p. 414.

the relation of the equation of the centre to the anomaly of a planet, are ſo far the ſame, that they are proportional to the ſine of that anomaly; and it becomes therefore neceſſary to ſearch among theſe hypotheſes, for that by which the ſeries of ſmall differences, deſcribed above, may be beſt repreſented. It is needleſs to enter here into any detail of the reaſonings by which this has been done, and by which I have found, that the argument in the table bears very nearly the ſame relation to the correſponding numbers, that the anomaly of the eccentric does to the equation of the centre. By the anomaly of the eccentric, however, I do not mean the angle which is known by that name in the ſolution of KEPLER's problem, but that which ſerves the ſame purpoſe with it, on the ſuppoſition of a circular orbit, and an uniform angular motion about a point which is not the centre of that orbit, but which is as diſtant from it, on the one ſide, as the earth (or the place of the obſerver) is on the other. It is the angle, which, in ſuch an orbit, the line drawn from the planet to the centre, makes with the line drawn from thence to the apogee; and the argument in the Indian tables coincides with this angle.

THIS hypotheſis of a double eccentricity, is certainly not the ſimpleſt that may be formed with reſpect to the motion of the heavenly bodies, and is not what one would expect to meet with here; but it agrees ſo well with the tables, and gives the equations from the arguments ſo nearly, eſpecially for the moon and the planets, that little doubt remains of its being the real hypotheſis on which theſe tables were conſtructed *.

54. OF

* THE formula deduced from this hypotheſis, for calculating the equation of the centre from the anomaly of the eccentric, is the following: Let x be the equation of the centre, φ the anomaly of the eccentric, e the eccentricity of the orbit, or the tangent of half the greateſt equation; then $x = 2e\,\textit{ſin}.\varphi + \frac{2e^3\,\textit{ſin}.3\varphi}{3} + \frac{2e^5\,\textit{ſin}.5\varphi}{5} + \&c.$

54. Of this, the method employed to calculate the place of any of the five planets from these tables, affords a confirmation. But, in reasoning about that method, it is necessary to put out of the question the use that is made of the parallax of the annual orbit, or of the *schigram*, in order to have the argument for finding the equation of the centre, which is evidently faulty, as it makes that equation to be affected by a quantity, (the parallax of the annual orbit), on which it has in reality no dependence. To have the rule free from error, it is to be taken, therefore, in the case when there is no parallax of the annual orbit, that is, when the planets are in opposition or conjunction with the sun. In that case, the mean anomaly is first corrected by the subtraction or addition of half the equation that belongs to it in the table. It then becomes the true argument for finding, from that same table, the equation of the centre, which is next applied to the mean anomaly, to have the true. Now, this agrees perfectly with the conclusion above; for the mean anomaly, by the subtraction or addition of half the equation belonging to it in the table, is converted, almost precisely, into the anomaly of the eccentric, and becomes therefore the proper argument for finding out the equation, which is to change the mean anomaly into the true *. There can be no doubt, of consequence, that the conclusion we have come to is strictly applicable to the planets, and that the orbit of each of them, in this astronomy, is supposed to be a circle, the earth not being in its centre, but the angular

* This method of calculation is so nearly exact, that even in the orbit of Mars, the equation calculated from the mean anomaly, rigorously on the principle of his angular motion being uniform, about a point distant from the centre, as described above, will rarely differ a minute from that which is taken out from the Indian tables by this rule. It was remarked, (§ 37.) that it is not easy to explain the rules for finding the argument of the equation of the centre, for the planets. What is said here explains fully one part of that rule, *viz.* the correction made by half the equation *manda*; the principle on which the other part proceeds, *viz.* the correction by half the equation *schigram*, is still uncertain.

velocity of the planet being uniform about a certain point, as far from that centre on the one fide, as the earth is on the oppofite.

55. Between the ftructure of the tables of the equations of the fun and moon, and the rules for ufing them, there is not the fame confiftency; for in both of them, the argument, which we have found to be the eccentric anomaly, is neverthelefs treated as the mean. So far as concerns the fun, this leads to nothing irreconcilable with our fuppofition, becaufe the fun's equation being fmall, the difference will be inconfiderable, whether the argument of that equation be treated as the eccentric or the mean anomaly.

But it is otherwife with refpect to the moon, where the difference between confidering the argument of the equation as the mean, or as the eccentric anomaly, is not infenfible. The authority of the precepts, and of the tables, are here oppofed to one another; and we can decide in favour of the latter, only becaufe it leads to a more accurate determination of the moon's place than the former. It would indeed be an improvement on their method of calculation, which the Brahmins might make confiftently with the principles of their own aftronomy, to extend to the moon their rule for finding the equation of the centre for the planets. They would then avoid the palpable error of making the maximum of the moon's equation at the time when her mean anomaly is 90°, and would afcertain her place every where with greater exactnefs. It is probable that this is the method which they were originally directed to follow.

56. From the hypothefis which is thus found to be the bafis of the Indian aftronomy, one of the firft conclufions which prefents itfelf, is the exiftence of a remarkable affinity between the fyftem of the Brahmins and that of Ptolemy. In the latter, the fame thing was fuppofed for the five planets,

that

that appears in the former to have been univerſally eſtabliſhed, *viz.* that their orbits were circles, having the earth within them, but removed at a ſmall diſtance from the centre, and that each planet deſcribed the circumference of its orbit, not with an uniform velocity, but with one that would appear uniform, if it were viewed from a point as far above the centre of the orbit, as that centre is above the earth. This point was, in the language of PTOLEMY's aſtronomy, the centre of the *Equant.*

Now, concerning this coincidence, it is the more difficult to judge, as, on the one hand, it cannot be aſcribed to accident, and, on the other, it may be doubted, whether it ariſes neceſſarily out of the nature of the ſubject, or is a conſequence of ſome unknown communication between the aſtronomers of India and of Greece.

THE firſt hypotheſis by which men endeavoured to explain the phenomena of the celeſtial motions, was that of a uniform motion in a circle, which had the earth for its centre. This hypotheſis was, however, of no longer continuance than till inſtruments of tolerable exactneſs were directed to the heavens. It was then immediately diſcovered, that the earth was not the centre of this uniform motion; and the earth was therefore ſuppoſed to be placed at a certain diſtance from the centre of the orbit, while the planet revolved in the circumference of it with the ſame velocity as before. Both theſe ſteps may be accounted neceſſary; and in however many places of the earth, and however cut off from mutual intercourſe, aſtronomy had begun to be cultivated, I have no doubt that theſe two ſuppoſitions would have ſucceeded one another, juſt as they did among the Greek aſtronomers.

BUT when more accurate obſervations had ſhewn the inſufficiency even of this ſecond hypotheſis, what ought naturally to be the third, may be thought not quite ſo obvious; and if the Greeks made choice of that which has been deſcribed above, it may

may ſeem to have been owing to certain metaphyſical notions concerning the ſimplicity and perfection of a circular and uniform motion, which inclined them to recede from that ſuppoſition, no farther than appearances rendered abſolutely neceſſary. The ſame coincidence between the ideas of metaphyſics and aſtronomy, cannot be ſuppoſed to have taken place in other countries; and therefore, where we find this third hypotheſis to have prevailed, we may conclude that it was borrowed from the Greeks.

57. Though it cannot be denied, that, in this reaſoning, there is ſome weight, yet it muſt be obſerved, that the introduction of the third hypotheſis did not reſt among the Greeks altogether on the coincidence above mentioned. It was one ſuited to their progreſs in mathematical knowledge, and offered almoſt the only ſyſtem, after the two former were exploded, which rendered the planetary motions the ſubject of geometrical reaſoning, to men little verſed in the methods of approximation. This was the circumſtance then, which, more than any other, probably influenced them in the choice of this hypotheſis, though we are not to look for it as an argument ſtated in their works, but may judge of the influence it had, from the frequency with which, many ages afterwards, the αγεωμετρησια of Kepler's ſyſtem was objected to him by his adverſaries; an objection to which that great man ſeemed to pay more attention than it deſerved.

There is reaſon therefore to think, that in every country where aſtronomy and geometry had neither of them advanced beyond a certain point, the hypotheſis of the equant would ſucceed to that of a ſimple eccentric orbit, and therefore cannot be admitted as a proof, that the different ſyſtems in which it makes a part, are neceſſarily derived from the ſame ſource. Some other circumſtances attending this hypotheſis, as it is found in the Indian tables, go ſtill farther, and ſeem quite inconſiſtent with the ſuppoſition that the authors of theſe tables

derived

derived it from the aſtronomers of the weſt. For, *firſt*, It is applied by them to all the heavenly bodies, that is, to the ſun and moon, as well as the planets. With PTOLEMY, and with all thoſe who founded their ſyſtems on his, it extended only to the latter, inſomuch that KEPLER's great reformation in aſtronomy, the diſcovery of the elliptic orbits, began from his proving, that the hypotheſis of the equant was as neceſſary to be introduced for the ſake of the ſun's orbit, as for thoſe of the planets, and that the eccentricity in both caſes, muſt be biſected. It is, therefore, on a principle no way different from this of KEPLER, that the tables of the ſun's motion are computed in the Indian aſtronomy, though it muſt be allowed, that the method of uſing them is not perfectly conſiſtent with this idea of their conſtruction.

2dly, THE uſe made of the anomaly of the eccentric in theſe tables, as the argument of the equation of the centre, is altogether peculiar to the Indian aſtronomy. PTOLEMY's tables of that equation for the planets, though they proceed on the ſame hypotheſis, are arranged in a manner entirely different, and have for their argument the mean anomaly. The angle which we call the anomaly of the eccentric, and which is of ſo much uſe in the Indian tables, is not employed at all in the conſtruction of his *, nor, I believe, in thoſe of any other aſtronomer till the time of KEPLER; and even by KEPLER it was not made the argument of the equation to the centre. The method, explained above, of converting the mean anomaly into that of the eccentric, and conſequently into the argument of the equation, is another peculiarity, and though ſimple and ingenious, has not the accuracy ſuited to the genius of the Greek aſtronomy, which never admitted even of the beſt approximation, when a rigorous ſolution could be found; and, on the whole, if the reſemblance of theſe two ſyſtems, even with all the exceptions that have been ſtated, muſt ſtill be aſcribed

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* Almageſt. lib. XI. cap. 9. & 10.

to ſome communication between the authors of them, that communication is more likely to have gone from India to Greece, than in the oppoſite direction. It may perhaps be thought to favour this laſt opinion, that PTOLEMY has no where demonſtrated the neceſſity of aſſigning a double eccentricity to the orbits of the planets, and has left room to ſuſpect, that authority, more than argument, has influenced this part of his ſyſtem.

58. IN the tables of the planets, we remarked another equation, (*ſchigram*) anſwering to the parallax of the earth's orbit, or the difference between the heliocentric and the geocentric place of the planet. This parallax, if we conceive a triangle to be formed by lines drawn from the ſun to the earth and to the planet, and alſo from the planet to the earth, is the angle of that triangle, ſubtended by the line drawn from the ſun to the earth. And ſo, accordingly, it is computed in theſe tables; for if we reſolve ſuch a triangle as is here deſcribed, we will find the angle, ſubtended by the earth's diſtance from the ſun, coincide very nearly with the ſchigram.

THE argument of this equation is the difference between the mean longitude of the ſun and of the planet. The orbits are ſuppoſed circular; but whether the inequality in queſtion was underſtood to ariſe from the motion of the earth, or from the motion of the planet in an epicycle, the centre of which revolves in a circle, is left undetermined, as both hypotheſes may be ſo adjuſted as to give the ſame reſult with reſpect to this inequality. The proportional diſtances of the planets from the earth or the ſun, may be deduced from the tables of theſe equations, and are not far from the truth.

59. THE preceding calculations muſt have required the aſſiſtance of many ſubſidiary tables, of which no trace has yet been found in India. Beſides many other geometrical propoſitions, ſome of them alſo involve the ratio, which the diameter of a circle was ſuppoſed to bear to its circumference, but which

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we would find it impoſſible to diſcover from them exactly, on account of the ſmall quantities that may have been neglected in their calculations. Fortunately, we can arrive at this knowledge, which is very material when the progreſs of geometry is to be eſtimated, from a paſſage in the *Ayeen Akbery*, where we are told, that the Hindoos ſuppoſe the diameter of a circle to be to its circumference as 1250 to 3927 *, and where the author, who knew that this was more accurate than the proportion of ARCHIMEDES, (7 to 22), and believed it to be perfectly exact, expreſſes his aſtoniſhment, that among ſo ſimple a people, there ſhould be found a truth, which, among the wiſeſt and moſt learned nations, had been ſought for in vain.

THE proportion of 1250 to 3927 is indeed a near approach to the quadrature of the circle; it differs little from that of METIUS, 113 to 355, and is the ſame with one equally remarkable, that of 1 to 3.1416. When found in the ſimpleſt and moſt elementary way, it requires a polygon of 768 ſides to be inſcribed in a circle; an operation which cannot be arithmetically performed without the knowledge of ſome very curious properties of that curve, and, at leaſt, nine extractions of the ſquare root, each as far as ten places of decimals. All this muſt have been accompliſhed in India; for it is to be obſerved, that the above mentioned proportion cannot have been received from the mathematicians of the weſt. The Greeks left nothing on this ſubject more accurate than the theorem of ARCHIMEDES; and the Arabian mathematicians, ſeem not to have attempted any nearer approximation. The geometry of modern Europe can much leſs be regarded as the ſource of this knowledge. METIUS and VIETA were the firſt, who, in the quadrature of the circle, ſurpaſſed the accuracy of ARCHIMEDES; and they flouriſhed at the very time when the Inſtitutes of AKBAR were collected in India.

* Ayeen Akbery, Vol. III. p. 32.

60. On the grounds which have now been explained, the following general conclufions appear to be eftablifhed.

I. The obfervations on which the aftronomy of India is founded, were made more than three thoufand years before the Chriftian era; and, in particular, the places of the fun and moon, at the beginning of the Calyougham, were determined by actual obfervation.

This follows from the exact agreement of the radical places in the tables of Tirvalore, with thofe deduced for the fame epoch from the tables of De la Caille and Mayer, and efpecially in the cafe of the moon, when regard is had to her acceleration. It follows, too, from the pofition of the fixed ftars in refpect of the equinox, as reprefented in the Indian zodiac; from the length of the folar year; and, laftly, from the pofition and form of the orbits of Jupiter and Saturn, as well as their mean motions; in all of which, the tables of the Brahmins, compared with ours, give the quantity of the change that has taken place, juft equal to that which the action of the planets on one another may be fhown to have produced, in the fpace of forty-eight centuries, reckoned back from the beginning of the prefent.

Two other of the elements of this aftronomy, the equation of the fun's centre, and the obliquity of the ecliptic, when compared with thofe of the prefent time, feem to point to a period ftill more remote, and to fix the origin of this aftronomy 1000 or 1200 years earlier, that is, 4300 years before the Chriftian era; and the time neceffary to have brought the arts of calculating and obferving to fuch perfection as they muft have attained at the beginning of the Calyougham, comes in fupport of the fame conclufion.

Of fuch high antiquity, therefore, muft we fuppofe the origin of this aftronomy, unlefs we can believe, that all the coincidences

cidences which have been enumerated, are but the effects of chance; or, what indeed were still more wonderful, that, some ages ago, there had arisen a NEWTON among the Brahmins, to discover that universal principle which connects, not only the most distant regions of space, but the most remote periods of duration; and a DE LA GRANGE, to trace, through the immensity of both, its most subtle and complicated operations.

II. THOUGH the astronomy which is now in the hands of the Brahmins, is so ancient in its origin, yet it contains many rules and tables that are of later construction.

THE first operation for computing the moon's place from the tables of Tirvalore, requires that 1,600,984 days should be subtracted from the time that has elapsed since the beginning of the Calyougham, which brings down the date of the rule to the year 1282 of our era. At this time, too, the place of the moon, and of her apogee, are determined with so much exactness, that it must have been done by observation, either at the instant referred to, or a few days before or after it. At this time, therefore, it is certain, that astronomical observations were made in India, and that the Brahmins were not, as they are now, without any knowledge of the principles on which their rules are founded. When that knowledge was lost, will not perhaps be easily ascertained; but there are, I think, no circumstances in the tables from which we can certainly infer the existence of it at a later period than what has just been mentioned; for though there are more modern epochs to be found in them, they are such as may have been derived from the most ancient of all, by help of the mean motions in the tables of Chrisnabouram *, without any other skill than is required to an ordinary calculation. Of these epochs, beside what have been occasionally mentioned in the course of our remarks, there is one (involved in the tables of Narsapur) as late as the year 1656, and another as early as the year 78 of our era, which

* Ast. Ind. p. 307.

which marks the death of SALIVAGANAM, one of their princes, in whose reign a reform is said to have taken place in the methods of their astronomy. There is no reference to any intermediate date, from that time to the beginning of the Calyougham.

THE parts of this astronomy, therefore, are not all of the same antiquity; nor can we judge, merely from the epoch to which the tables refer, of the age, to which they were originally adapted. We have seen, that the tables of Chrisnabouram, though they profess to be no older than the year 1491 of our era, are, in reality, more ancient than the tables of Tirvalore, which are dated from the Calyougham, or at least have undergone fewer alterations. This we concluded from the slow motion given to the moon, in the former of these tables, which agreed, with such wonderful precision, with the secular equation applied to that planet by MAYER, and explained by M. DE LA PLACE.

BUT it appears, that neither the tables of Tirvalore or Chrisnabouram, nor any with which we are yet acquainted, are the most ancient to be found in India. The Brahmins constantly refer to an astronomy at Benares, which they emphatically style *the ancient* *, and which they say is not now understood by them, though they believe it to be much more accurate than that by which they calculate. That it is more accurate, is improbable; that it may be more ancient, no one who has duly attended to the foregoing facts and reasonings, will think impossible; and every one, I believe, will acknowledge, that no greater service could be rendered to the learned world, than to rescue this precious fragment from obscurity. If that is ever to be expected, it is when the zeal for knowledge has formed a literary society among our countrymen in Bengal, and while that society is directed by the learning and abilities of Sir WILLIAM JONES. Indeed, the farther discoveries

* Ast. Ind. p. 309. M. LE GENTIL, Mem. Acad. Scien. 1772. P. II. p. 221.

ries which may be made with reſpect to this ſcience, do not intereſt merely the aſtronomer and the mathematician, but every one who delights to mark the progreſs of mankind, or is curious to look back on the ancient inhabitants of the globe. It is through the medium of aſtronomy alone that a few rays from thoſe diſtant objects can be conveyed in ſafety to the eye of a modern obſerver, ſo as to afford him a light, which, though it be ſcanty, is pure and unbroken, and free from the falſe colourings of vanity and ſuperſtition.

III. The baſis of the four ſyſtems of aſtronomical tables which we have examined, is evidently the ſame.

Though theſe tables are ſcattered over an extenſive country, they ſeem to have been all originally adapted, either to the ſame meridian, or to meridians at no great diſtance, which traverſe what we may call the claſſical ground of India, marked by the ruins of Canoge, Palibothra and Benares. They contain rules that have originated between the tropics; whatever be their epoch, they are all, by their mean motions, connected with that of the Calyougham; and they have beſides one uniform character which it is perhaps not eaſy to deſcribe. Great ingenuity has been exerted to ſimplify their rules; yet, in no inſtance almoſt, are they reduced to the utmoſt ſimplicity; and when it happens that the operations to which they lead are extremely obvious, theſe are often involved in an artificial obſcurity. A Brahmin frequently multiplies by a greater number than is neceſſary, where he ſeems to gain nothing but the trouble of dividing by one that is greater in the ſame proportion; and he calculates the era of Salivaganam with the formality of as many diſtinct operations as if he were going to determine the moon's motion ſince the beginning of the Calyougham. The ſame ſpirit of excluſion, the ſame fear of communicating his knowledge, ſeems to direct the calculus which pervades the religion of the Brahmin; and, in neither of them, is he willing to receive or to impart inſtruction. With all theſe circumſtances of reſemblance,

blance, the methods of this aſtronomy are as much diverſified as we can ſuppoſe the ſame ſyſtem to be, by paſſing through the hands of a ſucceſſion of ingenious men, fertile in reſources, and acquainted with the variety and extent of the ſcience which they cultivated. A ſyſtem of knowledge, which is thus aſſimilated to the genius of the people, that is diffuſed ſo widely among them, and diverſified ſo much, has a right to be regarded, either as a native, or a very ancient inhabitant of the country where it is found.

IV. The conſtruction of theſe tables implies a great knowledge of geometry, arithmetic, and even of the theoretical part of aſtronomy.

In proof of this, it is unneceſſary to recapitulate the remarks that have been already made. It may be proper, however, to add, that the method of calculating eclipſes, to which theſe tables are ſubſervient, is, in no reſpect, an empirical one, founded on the mere obſervation of the intervals at which eclipſes return, one after another, in the ſame order. It is indeed remarkable, that we find no trace here of the period of 6585 days and 8 hours, or 223 lunations, the *Saros* of the Chaldean aſtronomers, which they employed for the prediction of eclipſes, and which (obſerved with more or leſs accuracy) the firſt aſtronomers every where muſt have employed, before they were able to analyſe eclipſes, and to find out the laws of every cauſe contributing to them. That empirical method, if it once exiſted in India, is now forgotten, and has long ſince given place to the more ſcientific and accurate one, which offers a complete analyſis of the phenomena, and calculates, one by one, the motions of the ſun, of the moon, and of the node.

But what, without doubt, is to be accounted the greateſt refinement in this ſyſtem, is the hypotheſis employed in calculating the equations of the centre for the ſun, moon and planets, that, *viz.* of a circular orbit having a double eccentricity, or

or having its centre in the middle, between the earth and the point about which the angular motion is uniform *. If to this we add the great extent of geometrical knowledge requiſite to combine

* It ſhould have been remarked before, that M. Bailly has taken notice of the analogy between the Indian method of calculating the places of the planets, and Ptolemy's hypotheſis of the equant, though on different principles from thoſe that have been followed here, and ſuch as do not lead to the ſame concluſion. In treating of the queſtion, whether the ſun or earth has been ſuppoſed the centre of the planetary motions by the authors of this aſtronomy, he ſays, " Ils ſemblent avoir reconnu que les " deux inégalités (l'équation du centre et la parallaxe de l'orbe annuel) etoient vues de " deux centres differens ; et dans l'impoſſibilité où ils étoient de déterminer et le lieu et " la diſtance des deux centres, ils ont imaginé de rapporter les deux inégalités à un point " qui tînt le milieu, c'eſt-à-dire, à un point également éloigné du ſoleil, et de la terre. " Ce nouveau centre reſemble aſſez au centre de l'équant de Ptolemee. (Aſt. Ind. Diſc. Prel. p. 69.) The fictitious centre, which M. Bailly compares with the equant of Ptolemy, is therefore a point which biſects the diſtance between the ſun and earth, and which, in ſome reſpects, is quite different from that equant; the fictitious centre, which, in the preceding remarks, is compared with the equant of Ptolemy, is a point of which the diſtance from the earth is biſected by the centre of the orbit, preciſely as in the caſe of that equant. M. Bailly draws his concluſion from the uſe made of half the equation *ſchigram*, as well as half the equation *manda*, in order to find the argument of this laſt equation. The concluſion here is eſtabliſhed, by abſtracting altogether from the former, and conſidering the caſes of oppoſitions and conjunctions, when the latter equation only takes place. If, however, the hypotheſis of the equant ſhall be found of importance in the explanation of the Indian aſtronomy, it muſt be allowed that it was firſt ſuggeſted by M. Bailly, though in a ſenſe very different from what it is underſtood in here, and from what it was underſtood in by Ptolemy.

For what farther relates to the parts of the aſtronomy of Chaldea and of Greece, which may be ſuppoſed borrowed from that of India, I muſt refer to the 10th Chap. of the *Aſtronomie Indienne*, where that ſubject is treated with great learning and ingenuity. After all, the ſilence of the ancients with reſpect to the Indian aſtronomy, is not eaſily accounted for. The firſt mention that is made of it, is by the Arabian writers ; and M. Bailly quotes a very ſingular paſſage, where Massoudi, an author of the 12th century, ſays, that Brama compoſed a book, entitled, *Sind-Hind*, that is, *Of the Age of Ages*, from which was compoſed the book *Magbiſti*, and from thence the *Almageſt* of Ptolemy. Aſt. Ind. Diſc. prel. p. 175.

The fabulous air of this paſſage is, in ſome meaſure, removed, by comparing it with one from Abulfaragius, who ſays, that, under the celebrated Al Maimon, the 7th Khalif of Babylon, (about the year 813 of our era) the aſtronomer Habash compoſed three ſets of aſtronomical tables, one of which was *ad regulas Sind Hind ;* that is, as Mr Costard explains it, according to the rules of ſome Indian treatiſe of aſtronomy. (Aſiatic Miſcel. Vol. I. p. 34.) The *Sind-Hind* is therefore the name of an aſtronomical book that exiſted in India in the time of Habash, and the ſame, no doubt, which Massoudi ſays was aſcribed to Brama.

combine this, and the other principles of their aſtronomy together, and to deduce from them the juſt concluſions; the poſſeſſion of a calculus equivalent to trigonometry; and, laſtly, their approximation to the quadrature of the circle, we ſhall be aſtoniſhed at the magnitude of that body of ſcience, which muſt have enlightened the inhabitants of India in ſome remote age, and which, whatever it may have communicated to the weſtern nations, appears to have received nothing from them.

Such are the concluſions that ſeem to me to follow, with the higheſt probability, from the facts which have been ſtated. They are, without doubt, extraordinary; and have no other claim to our belief, except that, as I think has been fully proved, their being falſe were much more wonderful than their being true. There are but few things, however, of which the contrary is impoſſible. It muſt be remembered, that the whole evidence on this ſubject is not yet before the public, and that the repoſitaries of Benares may contain what is to confirm or to invalidate theſe obſervations.

XIV.

XIV. *On the* RESOLUTION *of* INDETERMINATE PROBLEMS. *By JOHN LESLIE*, A. M.

[*Read by Mr PLAYFAIR*, *Dec.* 1. 1788.]

IT is a fundamental principle in Algebra, that a problem admits of ſolution, when the number of independent equations is equal to that of the unknown quantities. If ſimple expreſſions only occur, the anſwers will always be found in numbers, either whole or fractional. But if the higher functions be concerned, the values of the unknown quantities will commonly be involved in ſurds, which it is impoſſible to exhibit on any arithmetical ſcale, and to which we can only make a repeated approximation. Hence the origin of that branch of analyſis which is employed in the inveſtigation of thoſe problems, where the number of unknown quantities exceeds that of the propoſed equations, but where the values are required in whole or fractional numbers. The ſubject is not merely an object of curioſity; it can be applied with advantage to the higher calculus. Yet the doctrine of indeterminate equations has been ſeldom treated in a form equally ſyſtematic with the other parts of algebra. The ſolutions commonly given are devoid of uniformity, and often require a variety of aſſumptions. The object of this paper is to reſolve the complicated expreſſions which we obtain in the ſolution of indeterminate problems, into ſimple equations, and to do ſo, without framing a number of aſſumptions, by help of a ſingle principle, which, though extremely ſimple, admits of a very extenſive application.

LET $A\times B$ be any compound quantity equal to another, $C\times D$, and let m be any rational number aſſumed at pleaſure; it is manifeſt that, taking equimultiples, $A\times mB = C\times mD$. If, therefore, we ſuppoſe, that $A = mD$, it muſt follow, that $mB = C$, or $B = \frac{C}{m}$. Thus two equations of a lower dimenſion are obtained. If theſe be capable of farther decompoſition, we may aſſume the multiples n and p, and form four equations ſtill more ſimple. By the repeated application of this principle, an higher equation, if it admit of diviſors, will be reſolved into thoſe of the firſt order, the number of which will be one greater than that of the multiples aſſumed. Hence the number of ſimple equations into which a compound expreſſion can be reſolved, is equal to the ſum of the exponents of the unknown quantities in the higheſt term. Wherefore a problem can be ſolved by the application of this principle, only when the *aggregate ſum*, formed by the addition of the exponents in the higheſt terms of the ſeveral equations propoſed, is *at leaſt* equal to the number of the unknown quantities, together with that of the aſſumed multiples.

WE ſhall illuſtrate the mode of applying our principle, in the ſolution of ſome of the more general and uſeful problems connected with this branch of analyſis.

PROBLEM I.

Let it be required to find two rational numbers, the difference of the ſquares of which ſhall be a given number.

LET the given number be the product of a and b; then by hypotheſis, $x^2 - y^2 = ab$; but theſe compound quantities admit of an eaſy reſolution, for $(x+y)(x-y) = a\times b$. If therefore we ſuppoſe $x+y = ma$, we ſhall obtain $x-y = \frac{b}{m}$; where m is arbitrary,

bitrary, and if rational, x and y muſt alſo be rational. Tranſpoſing the firſt equation, $x = ma-y$, and reducing the ſecond, $mx-my = b$, and tranſpoſing $mx = b+my$, and therefore, $x = \frac{b+my}{m}$; whence by equality $\frac{b+my}{m} = ma-y$, and reducing, $b+my = m^2a-my$, and tranſpoſing $2my = m^2a-b$, whence $y = \frac{m^2a-b}{2m}$; but $x = ma-y$, conſequently $x = \frac{m^2b+a}{2m}$. If $m = 1$; then $x = \frac{b+a}{2}$, and $y = \frac{b-a}{2}$.

Suppose it were required to find a number which, increaſed or diminiſhed by 10, would produce ſquares. It is obvious, that the number may be denoted, either by x^2-10, or y^2+10; whence $x^2-10 = y^2+10$, and tranſpoſing $x^2-y^2 = 5\times4$, and applying the above formulæ, $x = \frac{5m^2+4}{2m}$; if $m = 2$, then $x = 6$ and the required number 26.

PROBLEM II.

To find two numbers, the ſum of the ſquares of which ſhall be equal to the ſum of two given ſquares.

By hypotheſis, $x^2+y^2 = a^2+b^2$, and tranſpoſing $x^2-a^2 = b^2-y^2$, and, by reſolving into factors, $(x+a)(x-a) = (b+y)(b-y)$; whence, by ſubſtitution, $x+a = mb-my$, and $x-a = \frac{b+y}{m}$. Tranſpoſing the firſt equation, $x = mb-my-a$; reducing the ſecond, $mx-ma = b+y$, and tranſpoſing, $mx = ma+b+y$, and therefore $x = \frac{ma+b+y}{m}$; whence, $\frac{ma+b+y}{m} = mb-my-a$, and $ma+b+y = m^2b-m^2y-ma$, and tranſ-

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poſing $m^2y+y = m^2b-2ma-b$, that is, $y = \frac{m^2b-2ma-b}{m^2+1}$. But $x = mb-my-a$, and ſubſtituting, $x = \frac{m^2a+2mb-a}{m^2+1}$. Thus, if $a=5$, and $b=10$, and $m=2$; then $y = \frac{4.10-4.5-10}{5} = 2$, and $x = \frac{4.5+4.10-5}{5} = 11$; but $(11)^2+(2)^2 = 125 = (10)^2+(5)^2$.

Cor. If $b=0$, we ſhall obtain two ſquares, the ſum of which ſhall be a given ſquare. For $y = -\frac{2ma}{m^2+1}$, or $+\frac{2ma}{m^2+1}$, and $x = \frac{m^2a-a}{m^2+1}$. Thus, if $a=10$, and $m=2$, then $y = \frac{4.10}{5} = 8$, and $x = \frac{4.10-10}{5} = 6$, but $64+36 = 100$.

PROBLEM III.

To find two rational numbers, the ſquares of which, together with any given multiple of their product, ſhall be equal to a given ſquare.

By hypotheſis, $x^2+y^2+bxy = a^2$, and tranſpoſing $x^2+bxy = a^2-y^2$, and reſolving into factors, $x(x+by) = (a+y)(a-y)$; whence, by aſſumption, $x+by = ma-my$, and $x = \frac{a+y}{m}$. Tranſpoſing the firſt equation, $x = ma-my-by$; conſequently, $\frac{a+y}{m} = ma-my-by$, or $a+y = m^2a-m^2y-mby$, and again by tranſpoſing, $m^2y+mby+y = m^2a-a$; whence $y = \frac{m^2-1}{m^2+mb+1}\times a$. But $x = \frac{a+y}{m}$, wherefore $x = \frac{2m+b}{m^2+mb+1}\times a$.

Suppose

SUPPOSE $a = 22$, $b = 3$, and $m = 2$, then $x = \frac{4+3}{4+6+1} \times 22$ $= 14$, and $y = \frac{4-1}{4+6+1} \times 22 = 6$. But $196+36+252 = 484$ $= (22)^2$.

Cor. IF $b = 1$, the hypothesis will be $x^2+y^2+xy = a^2$; and $x = \frac{2m+1}{m^2+m+1} \times a$, and $y = \frac{m^2-1}{m^2+m+1} \times a$. Thus, if $a = 13$, and m $= 3$, then $x = \frac{6+1}{9+3+1} \times 13 = 7$, and $y = \frac{9-1}{9+3+1} \times 13 = 8$. But $49+64+56 = 169 = (13)^2$.

PROBLEM IV.

To find two numbers, such, that each, increased by unit, shall be a square, and their sum, increased by unit, a given square.

LET the numbers be denoted by x^2-1 and y^2-1, and the first condition will be observed. The last requires, that x^2-1+y^2-1+1, or $x^2+y^2-1 = a^2$. By transposition, x^2-1 $= a^2-y^2$, and by resolution, $(x+1)(x-1) = (a+y)(a-y)$; whence $x+1 = ma-my$, and $mx-m = a+y$. Transposing the first equation, $x = ma-my-1$; and transposing the second, $mx =$ $a+y+m$, and dividing, $x = \frac{a+y+m}{m}$, whence $\frac{a+y+m}{m} =$ $ma-my-1$, and reducing, $a+y+m = m^2a-m^2y-m$, or $m^2y+y = m^2a-2m-a$, and therefore $y = \frac{m^2a-2m-a}{m^2+1}$. But $x = \frac{a+y+m}{m}$, whence $x = \frac{m^2+2ma-1}{m^2+1}$.

SUPPOSE

SUPPOSE $a = 8$, and $m = 2$, then $x = \frac{4+32-1}{4+1} = 7$, and $y = \frac{4.8-4-8}{4+1} = 4$, and the numbers are 48 and 15; but $48+15+1 = 64 = (8)^2$.

PROBLEM V.

To find two squares which, diminished by unit, shall be in a given ratio.

BY hypothesis, $a : b :: x^2-1 : y^2-1$; whence the equation, $ay^2-a = bx^2-b$, and by resolution, $(ay+a)(y-1) = (bx+b)(x-1)$; wherefore by assumption, $ay+a = mx-m$, and $my-m = bx+b$. Transposing the first, $ay = mx-m-a$, and dividing $y = \frac{mx-m-a}{a}$. Transposing the second, $my = bx+b+m$, and dividing, $y = \frac{bx+b+m}{m}$, wherefore, $\frac{mx-m-a}{a} = \frac{bx+b+m}{m}$, and reducing $m^2x-m^2-ma = abx+ab+ma$, that is, $m^2x - abx = m^2+ab+2ma$, and therefore, $x = \frac{m^2+ab+2ma}{m^2-ab}$; but $y = \frac{bx+b+m}{m}$, consequently $y = \frac{m^2+ab+2mb}{m^2-ab}$.

SUPPOSE $a = 2$, $b = 3$, and $m = 3$; then $x = \frac{9+6+12}{9-6} = 9$, and $y = \frac{9+6+18}{9-6} = 11$; but $2 : 3 :: 80 : 120$.

Cor. 1. WHEN the numbers x and y are very great, it is obvious that the ratio of x^2-1 to y^2-1, will be nearly equal to that of x^2 to y^2; and consequently the ratio of $\sqrt{a}$ to $\sqrt{b}$ will be still more nearly equal to that of x to y. If a and b, besides,

be

be nearly equal, the approximation will be more accurate. Let $m = a$; then the denominator $m^2 - ab$ will be ſmall, and therefore the fractions large; whence, by ſubſtitution, $\sqrt{a} : \sqrt{b} :: \frac{a^2+ab+2a^2}{a^2-ab} : \frac{a^2+ab+2ab}{a^2-ab} = 3a^2+ab : 3ab+a^2 = 3a+b : 3b+a$, *nearly.*

Thus $\sqrt{49} : \sqrt{50} :: 197 : 199 :: 7 : 7+\frac{14}{197}$, whence $\sqrt{50} = 7{,}07107$, true to the laſt place.

Cor. 2. Let $m = \frac{a+b}{2}$; then $m^2 - ab = \left(\frac{a+b}{2}\right)^2 - ab = \left(\frac{a-b}{2}\right)^2$, which, when a and b are nearly equal, will be ſmall, and by ſubſtitution, $\sqrt{a} : \sqrt{b} :: \frac{\left(\frac{a+b}{2}\right)^2 + ab + a(a+b)}{\left(\frac{a+b}{2}\right)^2 - ab} : \frac{\left(\frac{a+b}{2}\right)^2 + ab + b(a+b)}{\left(\frac{a+b}{2}\right)^2 - ab}$, nearly; hence, by proper reductions, $\sqrt{a} : \sqrt{b} :: 5a^2+10ab+b^2 : 5b^2+10ab+a^2$. This formula is more intricate than the former, but ſtill more accurate. Thus, $\sqrt{9} : \sqrt{10} :: 405+900+100 : 500+900+81 = 1405 : 1481$, and $\sqrt{10} = 3{,}16209$, true to the laſt place.

PROBLEM VI.

Let it be required to find a number, ſuch that, if given multiples of it be increaſed by given numbers, the product of the ſums ſhall be a ſquare.

Let $(ex+f)(gx+h) = y^2$; by aſſumption $ex+f = my$, and $gx+h = \frac{y}{m}$. Tranſpoſing the firſt equation, and dividing, $x = \frac{my-f}{e}$. Reducing the ſecond, $mgx+mh = y$, and tranſpo-

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sing and dividing, $x = \frac{y-mb}{mg}$; whence, $\frac{my-f}{e} = \frac{y-mb}{mg}$, and reducing, $m^2gy-mfg = ey-meb$, and transposing, $m^2gy-ey = mfg-meb$, and consequently, $y = \frac{mfg-meb}{m^2g-e}$. Also $x = \frac{y-mb}{mg} = \frac{f-m^2b}{m^2g-e}$.

Suppose $(7x+6)(2x+1) = y^2$. If $m = 2$, then $x = \frac{6-4}{8-7} = 2$, and $y = \frac{24-14}{8-7} = 10$; but $20 \times 5 = 100 = (10)^2$.

Cor. Let $e = 1$, and $g = 1$; the hypothesis will become $(x+f)(x+b) = y^2$. In this case, we obtain $x = \frac{f-m^2b}{m^2-1}$, and $y = \frac{mf-mb}{m^2-1}$. Thus, if $(x+12)(x+2)$, where $f = 12$, and $b = 2$, and $m = \frac{3}{2}$; then $x = \frac{12-\frac{18}{4}}{\frac{9}{4}-1} = 6$, and $y = \frac{\frac{3}{2}\cdot 10}{\frac{9}{4}-1} = 12$; but $18 \times 8 = 144 = (12)^2$.

PROBLEM VII.

Let it be required to find rational values of x and y, in the general quadratic, $Ax^2+Bx+C = y^2$.

Case I. *When the first term is a square.*

Suppose $A = a^2$, when the expression becomes $a^2x^2+bx+c = y^2$; by transposition, $bx+c = y^2-a^2x^2$, and resolving into factors, $b(x+\frac{c}{b}) = (y+ax)(y-ax)$; whence, by assumption,

$x+$

$x+\frac{c}{b}=my-max$, and $b=\frac{y+ax}{m}$. Reducing the first equation, $bx+c=mby-mabx$, and $y=\frac{mabx+bx+c}{mb}$. Again, reducing the second, $mb=y+ax$, and $y=mb-ax$; consequently, $\frac{mabx+bx+c}{mb}=mb-ax$, or $mabx+bx+c=m^2b^2-mabx$, and therefore, $x=\frac{m^2b^2-c}{2mab+b}$. But $y=mb-ax$; therefore, $y=\frac{m^2ab^2+mb^2+ac}{2mab+b}$.

SUPPOSE $9x^2+7x+14=y^2$, and $m=2$; then $x=\frac{4.49-14}{4.21+7}=2$, and $y=\frac{4.147+2.49+42}{4.21+7}=8$; but $9.4+7.2+14=64=(8)^2$.

Cor. 1. LET $a=1$, the expression becomes $x^2+bx+c=y^2$; and $x=\frac{m^2b^2-c}{2mb+b}$, and $y=\frac{m^2b^2+mb^2+c}{2mb+b}$. Thus, if $x^2+4x+4=y^2$, and $m=2$; then $x=\frac{64-4}{16+4}=3$, and $y=\frac{64+32+4}{16+4}=5$; but $9+4.3+4=25=(5)^2$.

Cor. 2. WHEN the third term is wanting, the expression becomes $a^2x^2+bx=y^2$; and in this case, the formulæ will become by reduction, $x=\frac{m^2b}{2ma+1}$, and $y=\frac{m^2ab+mb}{2ma+1}$. Thus, if $9x^2+13x=y^2$, and $m=2$; then $x=\frac{52}{4.3+1}=4$, and $y=\frac{4.39+2.13}{4.3+1}=14$; but $9.16+4.13=196=(14)^2$.

Case II. *When the third term is a square.*

Suppose $C = c^2$, and the expreſſion is $ax^2+bx+c^2 = y^2$. By tranſpoſition, $ax^2+bx = y^2-c^2$, and by reſolution, $(ax+b)x = (y+c)(y-c)$; whence by aſſumption, $x = \frac{y+c}{m}$, and $ax+b = my-mc$. But from the ſecond equation, $x = \frac{my-mc-b}{a}$, conſequently, $\frac{my-mc-b}{a} = \frac{y+c}{m}$; whence $y = \frac{m^2c+mb+ac}{m^2-a}$, and $x = \frac{y+c}{m} = \frac{2mc+b}{m^2-a}$.

Suppose $3x^2+5x+16 = y^2$, and $m = 2$; then $x = \frac{16+5}{4-3} = 21$, and $y = \frac{16+10+12}{4-3} = 38$. But $3.(21)^2+5.21+16 = 1444 = (38)^2$.

Cor. 1. Let $b = 0$; then the expreſſion becomes $ax^2+c^2 = y^2$, and $x = \frac{2mc}{m^2-a}$, and $y = \frac{m^2c+ac}{m^2-a}$. Thus, $2x^2+9 = y^2$; if $m = 2$, $x = \frac{4\cdot3}{4-2} = 6$, and $y = \frac{4\cdot3+7\cdot3}{4-2} = 9$. But $2.(6)^2+9 = 81 = (9)^2$.

Cor. 2. If $b = 0$, and $c = 1$; then $ax^2+1 = y^2$, and $x = \frac{2m}{m^2-a}$, and $y = \frac{m^2+a}{m^2-a}$. Put $a = m^2-d$, and we ſhall obtain $x = \frac{2m}{d}$, and $y = \frac{2m^2-d}{d}$. Hence it is evident, that x and y will be expreſſed in whole numbers, when $2m$ is diviſible by d. Call the quotient n; then $x = n$, and $y = mn-1$; whence $\frac{y}{x} = \frac{mn-1}{n} = m-\frac{1}{n}$, or $m-\frac{d}{2m}$, which are the two firſt terms

of

of the *continued fraction* denoting $\sqrt{(m^2-d)}$, or $\sqrt{a}$. Thus, if $12x^2+1 = y^2$; then $\sqrt{12} = \sqrt{(16-4)} = 4 - \cfrac{1}{2 - \cfrac{1}{2\ \&c.}}$ and $x = 2$, and $y = 4.2-1 = 7$; for $12.4+1 = 49 = (7)^2$.

It is to be remarked, that, when $d = 1$, the values of x and y may be discovered from any given number of terms of the continued fraction.

Thus, if $3x^2+1 = y^2$; then $\sqrt{3} = \sqrt{(4-1)} = 2 - \cfrac{1}{4 - \cfrac{1}{4\ \&c.}}$;

whence $x = 4, 15, 56, 209$ &c. and $y = 7, 26, 97, 362$ &c.

If $a = m^2+d$, then $x = -n$, and $y = -mn-1$; but the expression $ax^2+1 = y^2$, will not be altered by changing the signs of x and y; whence $x = n$, and $y = mn+1$; consequently, x and y will be determined from the continued fraction $m + \cfrac{1}{n + \cfrac{1}{n + \&c.}}$ denoting $\sqrt{(m^2+d)}$. Thus, $20x^2+1 = y^2$; then $\sqrt{20} = \sqrt{(16+4)} = 4 + \cfrac{1}{2 + \cfrac{1}{2\ \&c.}}$ and $x = 2$, and $y = 4.2+1 = 9$; for $20.4+1 = 81 = (9)^2$.

We may observe, that if $d = 1$, the values of x and y, in the expression $(m^2+1)x^2 \pm 1 = y^2$, may be found by taking an even or odd number of terms, according as the sign $+$ or $-$ is to be adopted.

Cor. 3. Let $c = 0$, then $ax^2+bx = y^2$; and, in this case, $x = \frac{b}{m^2-a}$, and $y = \frac{mb}{m^2-a}$. Thus, $7x^2+4x = y^2$; if $m = 3$, then $x = \frac{4}{9-7} = 2$, and $y = \frac{3.4}{9-7} = 6$. For $7.(2)^2+4.2 = 36 = (6)^2$.

CASE III. *When* BB—4AC *is a square.*

LET $x^2+\frac{b}{a}x+\frac{c}{a}=D\times E$; then the divisors of ax^2+bx+c will be $\frac{a}{n}\times D$, and $n\times E$. But it appears, from the doctrine of equations, that the excesses of x above the roots of the quadratic, $x^2+\frac{b}{a}x+\frac{c}{a}=0$, are the divisors of the expression $x^2+\frac{b}{a}x+\frac{c}{a}$. Wherefore, $D=x+\frac{b+\sqrt{(b^2-4ac)}}{2a}$, and $E=x+\frac{b-\sqrt{(b^2-4ac)}}{2a}$. Hence, when $\sqrt{(b^2-4ac)}$ is a whole or fractional number, the expression ax^2+bx+c admits of resolution, and the divisors are $\frac{a}{n}\left(x+\frac{b+\sqrt{(b^2-4ac)}}{2a}\right)$ and $n\left(x+\frac{b+\sqrt{(b^2-4ac)}}{2a}\right)$. And when these are found, the solution will be obtained from Prob. VI.

SUPPOSE $14x^2+19x+6=y^2$, then $b^2-4ac=361-336=25$, and $D=\frac{14}{n}\left(x+\frac{19+5}{28}\right)$, and $E=n\left(x+\frac{19-5}{28}\right)$. If $n=2$, the divisors will be $\frac{14}{2}\left(x+\frac{6}{7}\right)=7x+6$, and $2\left(x+\frac{1}{2}\right)=2x+1$; whence, from Prob. VI. $x=2$, and $y=10$. For $14.4+19.2+6=100=(100)^2$.

CASE IV. *When the general quadratic can be resolved into factors, if diminished by a given square.*

LET $(ex+f)(gx+h)=y^2-d^2$, then $(ex+f)(gx+h)=(y+d)(y-d)$; whence $ex+f=my-md$, and $gx+h=\frac{y+d}{m}$.

By

By reducing the firſt equation, $x = \frac{my-md-f}{e}$; and by reducing the ſecond, $x = \frac{y+d-mb}{mg}$; whence $\frac{my-md-f}{e} = \frac{y+d-mb}{mg}$, and conſequently, $y = \frac{m^2dg+mfg+de-meb}{m^2g-e}$. But $x = \frac{my-md-f}{e}$, therefore alſo $x = \frac{2md-m^2b+f}{m^2g-e}$.

SUPPOSE $14x^2+31x+24 = y^2$; then, taking $9 = d^2$ from both ſides, $14x^2+31x+15 = y^2-d^2$; but $\sqrt{(b^2-4ac)} = \sqrt{(961-840)} = 11$; whence, if $n = 2$, the diviſors, by Caſe III. will be $7x+5$ and $2x+3$; wherefore, making $m = 2$, $x = \frac{12-12+5}{8-7} = 5$, and $y = \frac{24+20+21-42}{8-7} = 23$. For $14 \cdot 25+31 \cdot 5+24 = 529 = (23)^2$.

PROBLEM VIII.

Let c and d be known values of x and y in the expreſſion, $ax^2+b = y^2$, and from theſe let it be required to diſcover others.

SINCE $ax^2+b = y^2$, and $ac^2+b = d^2$, ſubtracting theſe equations, we ſhall obtain $ax^2-ac^2 = y^2-d^2$, and by reſolution, $(ax-ac)(x+c) = (y+d)(y-d)$; whence $ax-ac = my-md$, and $x+c = \frac{y+d}{m}$. From the firſt of theſe equations, $x = \frac{my-md+ac}{a}$, and from the ſecond, $x = \frac{y+d-mc}{m}$; whence $\frac{my-md+ac}{a} = \frac{y+d-mc}{m}$, and $y = \frac{m^2d+ad-2mac}{m^2-a}$, or $\frac{(m^2+a)d-2mac}{m^2-a}$. But x =

$= \frac{y+d}{m} - c$; therefore $x = \frac{2md-(m^2+a)c}{m^2-a}$. To ſimplify theſe formulæ, put $p = \frac{m^2+a}{m^2-a}$, and $q = \frac{2m}{m^2-a}$; then will $x = dq - cp$, and $y = pd - qac$. If c become negative, the conditions of the problem will not be affected. In this caſe, $x = pc+qd$, and $y = pd+aqc$. The values of x and y, obtained from either of theſe formulæ, may be repeatedly ſubſtituted for thoſe of c and d; and thus a variety of numbers will be diſcovered.

SUPPOSE $2x^2+7 = y^2$, then $c = 1$, and $d = 3$; and if $m = 2$, $p = \frac{4+2}{4-2} = 3$, and $q = \frac{4}{4-2} = 2$; whence $x = 3.1+2.3 = 9$ or 3, and $y = 3.3+4 = 13$ or 5. Again, $x = 3.9+2.13 = 53$ or 1, and $y = 3.13+4.9 = 75$ or 3. Or $x = 3.3+2.5 = 19$ or 1, and $y = 3.5+4.3 = 27$ or 3; and ſo repeatedly.

WE may obſerve, that the value of p is the ſame with that of y in Prob. VI. Cor. II. and the value of q the ſame with that of x. Whence, if $p = d$, and $q = c$, we ſhall obtain for the expreſſion $ax^2-1 = y^2$, $x = 2cd$, and $y = d^2+ac^2$. Thus, in the example, $2x^2-1 = y^2$, where $c = 2$, and $d = 3$, $x = 2.2.3 = 12$, and $y = 3.3+2.2.2 = 17$; and again, $x = 2.12.17 = 408$, and $y = 17.17+2.12.12 = 577$.

PROBLEM IX.

To find two rational numbers, the ſum of which ſhall be equal to a given number, and the ſum of their ſquares a ſquare.

BY hypotheſis, $x+y = a$, and $x^2+y^2 = z^2$. Tranſpoſing the ſecond equation, $x^2 = z^2-y^2$, and reſolving into factors, $x \times x =$

$=(z+y)(z-y)$; whence, $x=mz-my$, and $z+y=mx$; wherefore $mz=my+x$, and $z=\frac{my+x}{m}$; alſo, $z=mx-y$; conſequently, $my+x=m^2x-my$, and $y=\frac{m^2x-x}{2m}$. But from the firſt equation, $y=a-x$; wherefore $a-x=\frac{m^2x-x}{2m}$, and $x=\frac{2m}{m^2+2m-1}\times a$; conſequently, $y=\frac{m^2-1}{m^2+2m-1}$, and $z=\frac{m^2+1}{m^2+2m-1}\times a$.

SUPPOSE $a=23$, and $m=4$; then $x=8$, $y=15$, and $z=17$. For $8+15=23$, and $64+225=289=(17)^2$.

PROBLEM X.

To find two numbers, whoſe ſum ſhall be a given number, and the product of the ſums, formed by adding given numbers to them, a ſquare.

BY hypotheſis, $x+y=a$, and $(x+b)(y+c)=z^2$. From the ſecond equation, we obtain by aſſumption, $x+b=mz$, and $z=my+mc$; therefore, $z=\frac{x+b}{m}=my+mc$; and ſo $x=m^2y+m^2c-b$. But, from the firſt equation, $x=a-y$; conſequently, $m^2y+m^2c-b=a-y$, and $y=\frac{a+b-mc^2}{m^2+1}$; alſo $x=a-y=\frac{am^2+mc^2-b}{m^2+1}$, and $z=\frac{x+b}{m}=\frac{am+c^2+bm}{m^2+1}$.

SUPPOSE

SUPPOSE $a = 17$, $b = 6$, $c = 2$, and let $m = 2$; then $y = \frac{17+6-8}{4+1} = 3$, $x = \frac{68+8-6}{4+1} = 14$, and $z = \frac{34+4+12}{4+1} = 10$. But $14+3 = 17$, and $(14+6)(3+2) = 100 = (10)^2$.

PROBLEM XI.

Let it be required to find two numbers, ſuch that, if to each, their ſum and difference, unit be added, the numbers reſulting ſhall be ſquares.

THE firſt condition will be obſerved, if the numbers be denoted by x^2-1 and y^2-1. The hypotheſis will then require $x^2+y^2-1 = z^2$, and $x^2-y^2+1 = v^2$.

TRANSPOSING the firſt equation, $x^2-1 = z^2-y^2$, and reſolving into factors, $(x+1)(x-1) = (z+y)(z-y)$; whence, $x+1 = mz-my$, and $z+y = mx-m$; therefore, $z = mx-m-y = \frac{my+x+1}{m}$, from which we have $y = \frac{m^2x-x-m^2-1}{2m}$.

AGAIN, tranſpoſing the ſecond equation, $x^2-y^2 = v^2-1$, and reſolving, $(x+y)(x-y) = (v+1)(v-1)$, and by aſſumption, $x+y = pv-p$, and $v+1 = px-py$, and therefore, $v = px-py-1 = \frac{x+y+p}{p}$. Hence $y = \frac{p^2x-x-2p}{p^2+1}$.

BUT it was found, that $y = \frac{m^2x-x-m^2-1}{2m}$; wherefore,

$\frac{p^2x-x-2p}{p^2+1} = \frac{m^2x-x-m^2-1}{2m}$; and by reduction, x

=

$$= \frac{p^2m^2+p^2-4mp+m^2+1}{p^2m^2-2mp^2-p^2+m^2+2m-1}, \text{ or} = \frac{(m^2+1)(p^2+1)-4mp}{p^2((m-1)^2-2)+(m+1)^2-2}.$$

In the ſame manner, by finding the values of x in terms of y, &c. we obtain $y = \frac{m^2p^2-2m^2p+p^2-m^2+2p-1}{p^2m^2-2mp^2-p^2+m^2+2m-1}$, or $= \frac{m^2((p-1)^2-2)+(p+1)^2-2}{p^2((m-1)^2-2)+(m+1)^2-2}$.

PROBLEM XII.

To find three numbers, the product of any two of which, increaſed by unit, ſhall be a ſquare.

By hypotheſis, $xy+1 = v^2$, $xz+1 = s^2$, and $yz+1 = w^2$.

1. Transposing the firſt equation, $xy = v^2-1$, and reſolving, $x\times y = (v+1)(v-1)$, whence $y = mv-m$, and $v+1 = mx$; conſequently, $v = \frac{m+y}{m} = mx-1$, and $x = \frac{2m+y}{m^2}$.

2. Again, tranſpoſing the ſecond equation, $xz = s^2-1$, and reſolving, $x\times z = (s+1)(s-1)$; whence, $z = ps-p$, and $s+1 = px$; conſequently, $s = \frac{z+p}{p} = px-1$, and reducing, $x = \frac{z+2p}{p^2}$. But $x = \frac{2m+y}{m^2}$; wherefore $m^2z+2m^2p = 2mp^2+p^2y$, and $y = \frac{m^2z+2m^2p-2mp^2}{p^2}$.

3. Moreover, by the third equation, $yz = w^2-1$; whence, $y\times z = (w+1)(w-1)$, and $y = qw-q$, and $w+1 = qz$; wherefore, $w = \frac{y+q}{q} = qz-1$, and $y = q^2z-2q$.

But $y = \frac{m^2z+2m^2p-2mp^2}{p^2}$; consequently, $p^2q^2z-2p^2q = m^2z+2m^2p-2mp^2$, and $z = \frac{2p^2q+2m^2p-2mp^2}{p^2q^2-m^2}$. Now, $y = q^2z-2q$; whence by substitution, $y = \frac{2m^2pq^2-2mp^2q^2+2m^2q}{p^2q^2-m^2}$.

And because $x = \frac{2m+y}{m^2}$, we have also $x = \frac{2pq^2-2m+2q}{p^2q^2-m^2}$.

Cor. Let $m = 1$, then the formulæ will be more simple; $x = \frac{2pq^2+2q-2}{p^2q^2-1}$, $y = \frac{2pq^2-2p^2q^2+2q}{p^2q^2-1}$, and $z = \frac{2p^2q+2p-2p^2}{p^2q^2-1}$.

There is a remarkable case in which the above formulæ do not directly apply, the numerators and denominators vanishing at the same time. It is when $m = 1$, $p = 2$, and $q = \frac{1}{2}$. For, by art. 3. $y = \frac{2m^2pq^2-2mp^2q^2+2m^2q}{p^2q^2-m^2} = \frac{1-2+1}{1-1} = \frac{0}{0}$; wherefore the value of y may be expressed by any assumed number, n. But, by art. 1. $x = \frac{2m+y}{m^2} = y+2$; whence $x = n+2$. Also, by art. 2. $x = \frac{z+2p}{p^2} = \frac{z+4}{4}$; therefore $z+4 = 4n+8$, and $z = 4n+4$. Thus, 2, 4, 12; for $2\times4+1 = 9$, $2\times12+1 = 25$, and $4\times12+1 = 49$.

PROBLEM XIII.

To find a cube which shall be equal to the product of a square by a given number.

By hypothesis, $x^3 = ay^2$, and resolving, $x\times x^2 = a\times y^2$; whence $x = ma$, and $y^2 = mx^2$; but $x^2 = (ma)^2$, consequently,

y^2

$y^2 = m^3a^2$, and $y\times y = ma\times m^2a$; and by a fecond affumption, $y = pma$, and $m^2a = py$; but $x = ma$; whence $y = px$, and fince $y = \frac{m^2a}{p}$, $y = \frac{x^2}{ap}$; wherefore $\frac{x^2}{ap} = px$, and $x = ap^2$; but $y = px$, whence $y = ap^3$.

Suppose $a = 3$, and $p = 2$, th[illegible] $= 3\times(2)^2 = 12$, and $y = 3.(2)^3 = 24$. For $(12)^3 = 1728 = 3.(24)^2$.

PROBLEM XIV.

To find two numbers, the fum of which fhall be a given fquare, and the fum of their cubes a fquare.

By hypothefis, $x+y = a^2$, and $x^3+y^3 = z^2$. Dividing the fecond equation by the firft, we obtain $\frac{z^2}{a^2} = x^2 - xy + y^2$, or $\frac{z^2}{a^2} - y^2 = x^2 - xy$, and refolving into factors, $\left(\frac{z}{a}+y\right)\left(\frac{z}{a}-y\right) = x(x-y)$; whence, $x = m\left(\frac{z}{a}-y\right)$, and $\frac{z}{a}+y = m(x-y)$. By reducing the firft of thefe expreffions, $z = \frac{ax+may}{m}$; and by the fecond, $z = max-may-ay$; whence $\frac{ax+may}{m} = max-may-ay$, and $y = \frac{m^2x-x}{m^2+2m}$. But from the firft equation, $y = a^2-x$; wherefore, $\frac{m^2x-x}{m^2+2m} = a^2-x$, and therefore $x = a^2\times\frac{m^2+2m}{2m^2+2m-1}$. But $y = a^2-x$, confequently, $y = a^2\times\frac{m^2-1}{2m^2+2m-1}$.

 Alfo,

Alſo, becauſe $z=\frac{ax+may}{m}$, we have by ſubſtitution, $z=a^3\times\frac{m^2+m+1}{2m^2+2m-1}$.

Cor. 1. If $a=2m^2+2m-1$, two whole numbers may be always found, the ſum of which, and that of their cubes, ſhall be ſquares. For in this caſe, $x=(2m^2+2m-1)(m^2+2m)$, $y=(2m^2+2m-1)(m^2-1)$, and $z=(2m^2+2m-1)^2(m^2+m+1.)$

Thus, if $m=2$, we ſhall find $x=88$, $y=33$, and $z=847$. But $88+33=121=(11)^2$, and $(88)^3+(33)^3=717409=(847)^2$.

Cor. 2. If y be negative, we ſhall obtain two numbers, the difference of which, and that of their cubes, ſhall be ſquares. Put $m=\frac{p}{q}$, and ſubſtituting, $x=a^2\times\frac{\frac{p^2}{q^2}+\frac{2p}{q}}{\frac{2p^2}{q^2}+\frac{2p}{q}-1}$, $y=-a^2\times\frac{\frac{p^2}{q^2}-1}{\frac{2p^2}{q^2}+\frac{2p}{q}-1}$, and $z=a^3\times\frac{\frac{p^2}{q^2}+\frac{p}{q}+1}{\frac{2p^2}{q^2}+\frac{2p}{q}-1}$, and by reduction, $x=a^2\times\frac{p^2+2pq}{2p^2+2pq-q^2}$, $y=a^2\times\frac{q^2-p^2}{2p^2+2pq-q^2}$, and $z=a^3\times\frac{p^2+pq+q^2}{2p^2+2pq-q^2}$. If $a=2p^2+2pq-q^2$, we ſhall obtain whole numbers; for $x=(2p^2+2pq-q^2)(p^2+2pq)$, $y=(2p^2+2pq-q^2)(q^2-p^2)$, and $z=(2p^2+2pq-q^2)^2(p^2+pq+q^2)$.

These examples will probably be thought ſufficient to explain the application of this method to the ſolution of indeterminate problems in general, and to ſhew that it is not leſs extenſive, and much more uniform, than thoſe that are commonly in uſe.

XV.

XV. *A* DISSERTATION *on the* CLIMATE *of* RUSSIA. *By* MATTHEW GUTHRIE, M. D. *Physician to the Imperial Corps of Noble Cadets at St Petersburg*, F.R.SS. LOND. and EDIN.: *With two* LETTERS *from his Excellency* M. ÆPINUS, *Counſ. of State, Knt. of the Order of* St. ANNE, *&c. &c. &c.*

[*Read by Mr* ROBISON, *Nov.* 2. 1789.]

IN a paper publiſhed in the ſecond volume of the ſecond decade of the Medical Commentaries of Edinburgh, I mentioned a deſign of endeavouring to trace the influence of a cold climate on the human body and its diſeaſes, which ſhould form a contraſt with the many accounts publiſhed of late years relative to the effects of hot climates; and I likewiſe mentioned my having given a detached piece *, ſome years ago, as a commencement of the ſubject, in the ſixty-eighth volume of the Philoſophical Tranſactions of London, which contains matter neceſſary to illuſtrate ſome parts of the following Diſſertation.

I WAS induced to this deſign, by having met with nothing of the kind in the courſe of my reading; and by remarking that, whilſt warm countries ſeem to occupy the attention of many of the Faculty, the more northern regions appear to intereſt but very few of our learned brethren, although it is but natural to conclude that if one extreme of temperature is found to have much influence, the other can ſcarcely be entirely without it.

IN

* THE title of the Diſſertation mentioned above, is, The Antiſeptic Regimen of the Natives of Ruſſia.

In this point of view, the ſubject ſeems to me to merit investigation, ſince the diſcuſſion of it is an object to ſcience in general, and to medicine in particular. The plan, then, that I have chalked out to myſelf, as likely to throw light on the ſubject, is to give the Hiſtory of the Northern Climate in one paper, and that of its Phyſical Influence in another, as it appears in the new capital of Ruſſia, St Peterſburg, where I have reſided for many years. Theſe two Diſſertations will contain a number of facts and obſervations, from which Phyſicians, in the double ſenſe of the word, may draw concluſions; for I pretend to nothing more than the honour of laying the foundation of an important work to be proſecuted by others, and which will probably require many years to complete.

As to the execution of my plan: *Firſt*, I have made uſe of the meteorological regiſter, kept in the Imperial Academy of Sciences, as ſuch regiſter muſt be more cloſely attended to than that of any individual, whoſe private buſineſs muſt often call him abroad at the proper hours of obſervation.

2dly, I HAVE adopted the Academy's diviſion of the year into two ſeaſons only, as in fact we have but two, properly ſpeaking, *viz.* winter and ſummer, the one ſeaſon running into the other, without leaving well defined intermediate periods, to anſwer to what are called ſpring and autumn in the temperate climates. Nature appears to hurry in the north, by as quick a tranſition as poſſible, from the long ſevere winter into its ſhort but ardent ſummer; ſo that our thawing ſeaſon occupies the period of your ſpring: and the ſame kind parent ſeems to prolong the ſeaſon of vegetation, from a ſimilar wiſe intention, as long as poſſible, till ſurpriſed in a manner at once by the return of winter, without much of what may be called autumn weather.

3dly, I HAVE followed the plan of the academic regiſter, in prefixing to each ſeaſon an enumeration of the common phenomena which take place in it, ſuch as the quantity and duration of

of froſt, ſnow, rain, congelation, *&c.* as will be ſeen in the paper, adding to the ſhort note of the Academy on each article, a few remarks of my own, which I have collected during a long reſidence in the north.

4thly, MY calculations are all taken from the mean of fifteen years, as will be ſeen by the annexed regiſter, an abridgment of that kept by Profeſſor EULER, perpetual Secretary to the Imperial Academy of Sciences, with which he obligingly furniſhed me.

I AM happy to embrace this opportunity of acknowledging a number of ſimilar obligations for many years paſt, from our equally liberal and learned Profeſſors of the Imperial Academy of Sciences.

Laſtly, I HAVE added to the regiſter the comparative degrees of FAHRENHEIT and REAUMUR's thermometers, that anſwer to the given number of DE LISLE's ſcale, becauſe the firſt is in common uſe in Great Britain, and the ſecond in Ruſſia, as it ought to be (and I believe generally is) with the public every where from its greater ſimplicity.

The RUSSIAN WINTER,

With the common Phenomena attending it.

THE Ruſſian winter certainly muſt take the lead, when treating of the ſeaſons, both from its duration and conſequences in this northern ſituation. The duration of winter is generally from the end of September to the beginning of May, although we certainly have occaſionally very pleaſant weather in April, in ſpite of morning and evening froſt, which the ſun, in his nearer approach, diſſipates inſtantly on appearing above the horizon; nay, the agreeable effect which a little of his ſenſible influence has, when contraſted with his little more than lunar action for ſo long a period, leads us to give to April almoſt the rank of a ſummer month, although I doubt if, in a more

ſouthern

ſouthern country, it would merit that appellation under the ſame circumſtances.

Duration of Froſt and Snow.

THE duration of winter, if it is to be defined by the mean term of froſt and ſnow, according to the common method, muſt be dated from the 9th of October to the beginning of May, when its force is ſo far ſpent as to be perceptible only by a ſlight hoar-froſt at an early morning hour; and as the continuance of ſnow is generally much the ſame as that of froſt, we may reckon the mean period of both at about 230 days in the year.

Term of the Rivers remaining Frozen.

BUT the duration of what is called the real Ruſſian winter, when our communication by water with the reſt of the world is ſhut up, and that element confounded in appearance, and almoſt in ſolidity, with the land, is conſiderably ſhorter, and is to be reckoned from the 27th of November to the 19th of April, (its mean term for fifteen years paſt), that is to ſay, it comprehends about 160 days in the year; for in the ſeaſon allotted to winter by the ordinary definition, as given above, there are about 70 days, when our froſt, although equal to the congelation of water in its tranquil ſtate, is incapable to arreſt the rapid current of rivers. Nay, I am yet to learn what degree of it might be required for that purpoſe; for in this country there are certain circumſtances which uſually accelerate the congelation of rapid rivers, ſuch as, their ſurface being covered with floating ice, formed in the lakes * above, which, at

* As for example, the floating ice which covers the Neva, and ſo much facilitates its congelation, is formed in the Ladoga lake, where an inferior degree of froſt can act upon the ſtill water, to what is neceſſary to congeal the river, and on the firſt wind it is broke up and carried down by the current.

at the firſt obſtacle it meets with in its courſe down the river, (as at the bar a little below the city of Peterſburg) accumulates ſo as to form one uniform ſheet to appearance, for many miles above the obſtacle, compoſed of a number of large thick flakes, which the ſevere froſt that commonly prevails about that time, almoſt inſtantly cements together, although the ſame degree of froſt is much inadequate to the power of congealing the naked ſurface of the running river. By this œconomy of nature, although the northern countries are much interſected by large and rapid rivers, which, from the floating ice, do not admit of ſtanding bridges, ſtill the communication is ſeldom interrupted for twenty-four hours, as they ſhut up with a degree of thickneſs ſufficient to bear the weight of a man almoſt immediately, and heavy burdens in a few days.

Thickneſs and other Phenomena of the Ice.

By February, our ice has acquired the aſtoniſhing thickneſs of about three quarters of an Engliſh yard, and, what is equally aſtoniſhing, it has loſt not above a third of it, when become ſo weak, at the breaking up of the rivers, as not to ſupport the weight of a dog. At this period, I have paid particular attention to its appearances, and found the maſs compoſed of a number of long ſolid cryſtals, reſembling, in ſome meaſure, the pipes of an organ, about half a yard long, but almoſt without adheſion, ſo that the maſs ſeems to have loſt little but the cementing principle, (if I may be allowed the expreſſion) which bound thoſe cryſtals together; inſtead of its being reduced, according to the common opinion, to a pellicle, by the action of the ſun and water on its upper and under ſurfaces, which any one may convince himſelf is a vulgar prejudice, by ſimple inſpection of a piece of the floating ice on the breaking up of the Neva, which, although ſunk ſo deep in the water as

to appear only like a pellicle above the ſurface, has the conſiderable thickneſs that I have mentioned, concealed below the water.

I MAY here ſubjoin ſome obſervations on the conducting power of ice with reſpect to ſound. This is affirmed to be very great, by the ingenious Profeſſor of Natural Philoſophy in your Univerſity *. I am diſpoſed to accede to his opinion, from knowing, that even the unbroken and uncultivated ground of our ſtepps or deſarts conducts ſound ſo well, that the Coſſacks hear the tread of a horſe at a great diſtance, by laying their ear to the ground. Experiments might be tried in this country on a very great ſcale. But as I have not had an opportunity of this kind ſince the thought ſtruck me, I ſhall content myſelf with giving the following extract of a letter from a friend: "Having walked out on the ice to a great diſtance from our fort "the other day, when its cannon were diſcharged for the taking "of Oxakow, the firſt intimation I received of this event "was, by a diſagreeable ringing ſound from the ice, and, after "ſome ſeconds, the uſual report through the air, but not ſo "violent as the firſt."

Regiſter of the Weather for the ſix Winter Months.

THERMOMETER.

OUR greateſt cold exceeds in general 196° of DE LISLE's, equal to 24° below 0 of FAHR. or 24°½ of REAUM. below 0, and commonly obtains in January.

OUR mean cold for the ſix winter months is, in the afternoon, 154°, equal to 27° of FAHR. above 0, or equal to 2° of REAUM. below 0; Night, 162°, equal to 23° of FAHR. above 0, or to 7° of REAUM. below 0.

IT muſt always be remembered, that they are the mean degrees of cold and heat during a period of fifteen years, which are

* JOHN ROBISON, M. A. Profeſſor of Natural Philoſophy in the Univerſity of Edinburgh.

are set down in this register; for we have often, for example, a more considerable degree of cold than what is indicated above, as our greatest during the season; 27° of REAUM. or 62° of FAHR. below 0, are often felt here, and sometimes as far as 30°; nay, a cold of 32° below the freezing point of REAUM. is upon record, which is the freezing point of the purest mercury, according to my experiments, published here in 1785.

IT must be also remarked, that the thermometer sometimes has a surprising range during winter, so as to produce a change of temperature from 10° to 25° of REAUM. (or from 23° to 57° of FAHR.) in 24 hours; a trying circumstance for delicate constitutions, and which the most robust feel after the prime of life. The pressure of the air on the body is also equally variable in 24 hours, as indicated by the barometer on these occasions.

BAROMETER.

Placed 20 feet above the mean level of the Neva, and at 6000 from its opening into the gulph of Finland.

Highest,	28.87	oftenest in January.
Lowest,	26.99	oftenest in November.
Difference,	1.88	
Mean height,	28.02	Paris inches.

Winds.

THE prevailing wind during winter is the west, and its proportion to the east is,

West, 113 days in the six winter months.
East, 68 days in the same period.

N.B. THE south wind, and all to the west of the meridian, is reckoned west; the north wind, and all to the east of the meridian, is reckoned east.

THIS circumſtance of the weſt and ſoutherly winds prevailing during the ſevere northern winter, muſt appear rather ſingular to moſt people, eſpecially in Great Britain, where the very name of N. and N. E. winds conveys the idea of cold. But this phenomenon may eaſily be explained on the principles advanced by Profeſſor ROBISON, in the Notes to Dr ROBERTSON's Hiſtory of America. *Vide* Note 4. B. IV.

Mean Quantity of melted Snow and Rain.

THESE together do not amount, in the ſix winter months, to more than about five Paris inches, although the whole ſurface of the northern countries is covered with ſnow to a conſiderable depth, over which we drive in ſledges, without diſtinguiſhing between land and water; whilſt, during ſummer, a period apparently fair in compariſon, there falls more than double the quantity of rain; but indeed, as it pours in torrents, when it does rain, like thunder-ſhowers in hot ſeaſons, there muſt fall more than the apparent dryneſs of the ſeaſon would lead one to ſuppoſe at firſt ſight, eſpecially when the large portion furniſhed by the heavy night-dews, is added to the quantity.

I MUST here obſerve, that water ſeems to acquire ſome new properties, from being converted into ſnow, froſt, incruſtations, and even common river ice, if we are to judge from the following facts: *Firſt*, I have ſhewn, in a paper publiſhed in the Philoſophical Tranſactions of London, that the frozen incruſtation, which is formed on the inſide of the windows, in the habitations of the lower claſs of people in this country, during the ſevere part of winter, (an inconvenience avoided in the better ſort of houſes by double windows), ſets looſe, on thawing, a ſpecies of mephitic air, producing all the dangerous effects of the fumes of charcoal on people expoſed to its action.

2dly,

2dly, A Mr SCHROETER of this city has found the water of theſe incruſtations to be of a very volatile nature; and indeed the ſolutions of all the frigorific productions mentioned above, poſſeſs a ſuperior diſpoſition to evaporate to river water in its natural ſtate, as is ſhown by the following experiment:

HE poured into five tea-cups, ſtanding in the window of his room, a tea-ſpoonful of each of the five different fluids mentioned below, when, at the expiration of 24 hours, their comparative degrees of evaporation were as follow:

No. 1. A tea-ſpoonful of window cruſt water was almoſt all evaporated.
2. ————— hoar froſt water had loſt about the half.
3. ————— ſnow water had loſt about a third.
4. ————— Neva ice water had loſt rather leſs than a third.
5. ————— River Neva water had loſt nothing to appearance.

Hail.

ITS appearance is a rare phenomenon in this ſeaſon: But I ſhall leave to the ingenious author of the Theory of Rain *, (in the firſt volume of the Tranſactions of the Royal Society of Edinburgh) to give a reaſon why water ſhould conſtantly take the form of ſnow during the ſevere weather of the north, and ſo ſeldom that of hail. Can it be that the ſun has not ſufficient influence, at this period of the year, to raiſe it to the higher region, where the form of hail is ſuppoſed to be given?

Tempeſts

ARE equally uncommon with hail in the ſeaſon treated of. Indeed nature ſeems to have ſtudied a perfect equality in the diſtribution of her favours, as it is only the parts of the earth which

* Dr JAMES HUTTON.

which moſt enjoy the kindly influence of the ſun, that ſuffer by the effects of its ſuperior heat; ſo that if the atmoſphere of the north is not ſo genial as that of the ſouth, at leaſt it remains perfectly quiet and ſerene, without threatening deſtruction to man and the product of his induſtry, as in what are commonly called happier climates.

Aurora Borealis.

As to the Aurora Borealis, it often illuminates our hemiſphere, more particularly in winter, when it appears from ſixteen to ſeventeen times in the ſix months, although we, by no means, enjoy ſo much of its light as our more northern neighbours, who have certainly a better title to its ſervices, from the beautiful plan of equality mentioned above. Some remarks which I ſhall make in the next article but one, may probably ſtrengthen the opinion of its being an electric phenomenon, that is to ſay, if proving the atmoſphere in general to be uncommonly electric, at the time of its greateſt prevalency, can lead to a preſumption of its connection with that fluid.

Parheliums and Mock Moons

Are ſeen pretty frequently in the north. Probably our frozen miſts and vapours make theſe phenomena more frequent here than in the temperate climates.

General Obſervations on the Winter Atmoſphere.

The air, though cold, is remarkably pure and elaſtic during our ſevere froſt, ſo as to give a moſt ſurpriſing degree of ſpring and tone to the human frame. At this time the atmoſphere is moſt aſtoniſhingly electric, even more ſo than during our violent thunder-ſtorms in ſummer, if we are to judge from the great

great power of our electrical machines, and from ſeveral other phenomena too curious to be paſſed over in ſilence.

THE moſt ſtriking of theſe is the appearance of a flame, on drawing a flannel cover off a ſilk chair, or on rubbing with a woolen cloth the ſilk hangings of an apartment. On this laſt operation, a flame was ſeen running along the gold-laced border, to the great amazement of the Imperial ſervants, to whom theſe alarming meteors appeared, on duſting the apartments of the palace in a dark winter morning, as I remember to have heard at the time, though many years ago. But the facts of this nature, which I got from our ingenious and learned electrician M. ÆPINUS *, whilſt Preceptor to his Imperial Highneſs the Great Duke, are much more circumſtantial and intereſting. See his letter at the end.

HOWEVER, I do not mean to aſſert, that the total of the electric fluid contained in the atmoſphere is greater in winter than ſummer, during the violent commotions it occaſions here, which are ſometimes of a very alarming and dangerous nature. I only ſay, that it appears to be more equally diffuſed through the whole volume of the atmoſphere, from not being collected into clouds, as in ſummer, and that the air is in a ſtate more diſpoſed to part with it. In fact, no clouds are to be ſeen during ſevere froſt, nor indeed can water exiſt in that form, but is divided into infinitely ſmall particles, frozen into ſhining ſpicula, which play and ſparkle in the beams of our bright though feeble ſun, in a very beautiful manner. This appearance of ſomething like brilliant points floating in our atmoſphere,

* As it may operate to the encouragement of Science, permit me to inform the Society, that when this reſpectable Philoſopher (ſo well known in Europe by his profound and ingenious writings on Electricity and Magnetiſm) had finiſhed the education of his Imperial Highneſs the Grand Duke of Ruſſia, he was advanced to the rank of actual Counſellor of State, with a penſion to ſupport his new dignity, and was decorated with the red ribbon of St ANNE, an order only beſtowed on men of high military or civil rank. This anecdote ſhows how well the preſent Sovereign underſtands rewarding merit, when it falls under her immediate cogniſance.

ſphere, is not conſtant, but I think follows a ſort of cloudineſs, which occaſionally takes place on a change of temperature, as if it was going to ſnow; but on the cold increaſing a few degrees, which it does often very ſuddenly, the ſky becomes inſtantly clear again, and ſeems to have acquired the little particles in queſtion, which I have often thought I felt acting againſt my face, while driving with great velocity in a ſledge.

THAT I may ſeparate as much as poſſible theory from facts, I reſerve to this place ſome explanation of what I have ſaid above, and beg leave to hazard a conjecture, in form of a query, for thoſe who have more leiſure and genius than myſelf. It would indeed be difficult to reconcile the idea of our atmoſphere poſſeſſing a greater quantity of electric fluid in winter than ſummer, with the diſcoveries of Meſſrs DE VOLTA and SAUSSURE, who have found the electricity of the air in dry weather to be conſtantly poſitive. The laſt mentioned gentleman ſuppoſes its poſitive ſtate to be maintained by a regular ſupply of vapours from the earth, (which are diſcovered to abound with that fluid) carrying up a portion of the electricity that belongs to the globe. Now, as in the north the earth is hard frozen during winter, one ſhould think the ſupply by evaporation cannot be ſo great in this ſeaſon as in ſummer, and of courſe its poſitive ſtate with difficulty kept up from this ſource, according to Dr FRANKLIN's Theory of Plus and Minus. Will that of two diſtinct fluids (to which Mr SAUSSURE ſeems to lean in ſome part of his works) account for it better? There is a theory very prevalent in Germany and Sweden; nay, we even find the reſpectable names of BERGMAN, SCHEELE, WILKE, *&c.* amongſt its advocates. This is a ſufficient reaſon for my giving it a place in this paper, leſt it ſhould not be generally known in Britain.

POSITIVE electricity is ſuppoſed to be common air ſaturated with heat or fire, as they term it; negative electricity is ſuppoſed to be phlogiſton, combined with an acid. As to the

commotion,

commotion, they account for it, by ſuppoſing that it is owing to the air and phlogiſton ruſhing with violence together, (from great affinity) and ſuddenly ſetting looſe the heat contained in the air, according to CRAWFORD's theory, which then becomes ſenſible, and in ſome caſes viſible. I muſt take the liberty of ſuggeſting a doubt if this new theory will account for ſo many phenomena in electricity, as the beautiful and ſimple one of FRANKLIN and ÆPINUS, particularly for Earl STANHOPE's returning ſtroke, which his Lordſhip proves to have been the death of Mr BRYDEN's carter and horſes, in ſo ſatisfactory a manner, that no man in future will think himſelf ſafe in a thunder-ſtorm, however diſtant from the exploſions.

IT might be ſuppoſed, from the ſeverity of the froſt mentioned above, that we ſuffer much cold during this period; but the fact is juſt the reverſe: for people in eaſy circumſtances, who are not obliged to remain much out of doors, but drive, or even walk from one houſe to another, ſuffer leſs than in moſt countries, as there reigns conſtantly a ſummer heat from 14° to 16° of REAUMUR in our apartments, where flowers blow all the winter; and when out of doors, the warm fur dreſs, with the ſkin furniture of the ſledges, (a coach requires none) keep the body ſo comfortable, that I am convinced leſs cold is felt (difference of dreſs conſidered) in driving through the ſtreets of Peterſburg in our cold dry air, than through thoſe of London or Edinburgh, during the cold moiſt weather that obtains there during a great part of the winter; eſpecially as this ſtate of the atmoſphere in Britain is often accompanied by bleak winds, whilſt the air in Ruſſia, during our greateſt cold, is generally ſerene and calm. In fact, we have only the face to guard againſt the froſt when out of doors, by occaſionally raiſing the cape of our fur garb, as all the reſt is ſecured againſt its attack by the well contrived dreſs of the north; and at home, if the door is only kept ſhut, the cold can enter from no other quarter, (the windows being double, well caulked and

 papered

papered in the ſeams) to counteract the equally diffuſed heat produced by well contrived ſtoves, which are built generally of white tiles, and admit of much latitude of elegant form.

THE above deſcription of our mode of living in winter, accounts for a circumſtance that has been regarded as affectation, both in the natives of Ruſſia, and in foreigners who have reſided long here, *viz.* their complaining of cold during winter in the temperate climates; for, on taking into conſideration their mode of living at home, there is nothing more natural than their ſuffering cold in countries where neither the houſes nor dreſs are calculated to keep it from conſtantly acting on the body, during a certain period of the year. This is a ſituation quite new to a Ruſſian, and which produces ſenſations more diſagreeable than can eaſily be imagined, till cuſtom makes it familiar, and that they have learned to ſeek heat in exerciſe, inſtead of ovens and furs; a leſſon by no means unprofitable to people of faſhion from the northern countries of Europe.

SPRING.

As to ſpring, I muſt again repeat my remark in the introduction, that we can hardly ſay that it exiſts here; the ſeaſons of winter and ſummer running into one another, almoſt without any ſenſible intermediate one: For by the time that the immenſe maſs of ſnow and ice, which covered the face of land and water, is melted, the ſun has acquired ſo much influence, as to dart on us at once a ſummer heat. It is probable that the quantity of water produced by this operation, when joined to the effect of our heavy night-dews in the hot weather, may render a wet intermediate ſeaſon unneceſſary, whilſt the ſhort period allowed to hurry vegetation through all its ſtages, will ſcarcely admit of it. Is it not poſſible, likewiſe, that the ſudden commencement of ſummer on the finiſhing of the thawing proceſs, may be accounted for, in ſome meaſure, by Dr BLACK's

Theory

Theory of Latent Heat? For as water requires a great portion of ſenſible heat to reſume its fluid form, of courſe, a large proportion of that furniſhed by the ſun will be abſorbed, until the whole is diſſolved, when we at once receive all his influence, without any part of it being abſorbed by our winter covering. When this cauſe is joined to the cold produced by the evaporation going on during the thawing period, it is eaſy to conceive how different our feelings muſt be at the time when they are both removed, and the earth is beginning to acquire and give out warmth; which very quickly takes place in this light ſandy ſoil, that lets the water readily filter through it, and almoſt immediately begins to heat.

RUSSIAN SUMMER,

With the common Phenomena attending it.

Our Ruſſian ſummer, during a good ſeaſon, preſents exactly the oppoſite extreme to winter, the former being nearly as hot as the latter is cold; an admirable arrangement of nature, if we conſider the taſk the ſun has to perform, with regard to vegetation, during that ſhort ſpace of time. The influence of the ſun during the period of a Ruſſian ſummer, is no doubt aided by that equally wiſe œconomy relative to the habits of plants; for whilſt the northern ones run their courſe uniformly in the ſhort ſpace of time allotted to them, (even in Iceland, where, from its inſular ſituation, the heat cannot be ſo conſiderable as with us), thoſe imported from the ſouth can, by no means, effect all their ſtages of vegetation, within the bounds of a Ruſſian ſummer, until they have paſſed a few ſeaſons in this climate, and thus acquired the habits of the indigenous plants of the country.

It is remarkable, that the thermometer falls exactly to $24°\frac{1}{2}$ of Reaumur below the freezing point, during our greateſt cold

cold in winter, and riſes to the ſame number of degrees above it, during our greateſt heat of ſummer, taking the mean of fifteen years. The ſun's remaining ſo many hours above the horizon, or rather ſcarcely leaving it at all during a certain period of our ſummer, affords one reaſon for the violent heat which a traveller meets with, to his no ſmall aſtoniſhment, in the latitude of 60, as the air and earth have not time to cool in the ſhort interval between his ſetting and riſing again. Two Britiſh travellers from Bengal, (where they are certainly accuſtomed to great heat) complain much of that of the preſent ſummer in St Peterſburg.

I TAKE this opportunity of mentioning a curious fact connected with northern vegetation. There is a diſh to be found at the tables of Moſcow during winter, which will ſcarcely be credited by the reſt of Europe, when it is remembered that the climate is nearly as ſevere as at Peterſburg, *viz.* aſparagus, reared in the open air, the production of a ſpecies of Ruſſian gardening, which merits being known.

IN autumn, the aſparagus beds are covered with mats, and buried by the falling ſnow, which is moſt abundant in this climate, ſo as to preſerve the plants from being frozen, until they are wanted. When a bed of them is to be thrown into vegetation during winter, it is done by cutting a deep and broad trench all around it, down to the unfrozen earth, which is filled with ſmoking dung, taken out of the middle of a large dunghill; the old mats, covered with ſnow, are then removed, and dry ones put in their place, and upon them a thick layer of warm dung, leaving only ſmall apertures for the plants to puſh through.

Regiſter

Register of the Weather for the six Summer Months.

THERMOMETER.

Greatest heat, 106° commonly in July or August, equal to 85° of FAHR. above 0, or to $24°\frac{1}{2}$ of REAUM. above 0.

Least heat, 144° in May or October, equal to 41° of FAHR. above 0, or to 3° of REAUM. above 0.

Difference, 38° equal to $46°\frac{1}{2}$ of FAHR. or equal to $20°\frac{1}{2}$ of REAUM.

Mean heat of the aftern. 127° equal to 59° of FAHR. above 0, or equal 12° of REAUM. above 0.

Mean heat of the night, 136° equal to 49° of FAHR. above 0, or to $2°\frac{1}{2}$ of REAUM. above 0.

Mean heat of the climate at large, $2°\frac{7}{10}$.

BAROMETER.

At highest, 28.42 oftenest in May.
At lowest, 27.50 oftenest in September.

.92 The middle between these extremes is 27.96.
Mean height, 28.04 Paris inches.

Winds.

THE wind that predominates here in summer, as in winter, is the west.

West wind,	110	days.
East wind,	84	days.

Rain,

Rain.

THE quantity of rain that falls in the ſix months, is $10\frac{99}{100}$, or about 11 Paris inches.

Rainy days,	- -	80.
Tempeſt during this ſeaſon,	from	11 to 12.
Showers of hail,	from	2 to 3.
Aurora Borealis,	from	8 to 9.
Fog,	- -	17 days.

I SHOULD be happy in being able to give the heat of deep wells and ſprings in this province, to compare with the mean heat of our climate, which, according to a curious modern diſcovery, ought to be pretty nearly the ſame; but as our water lies within about four yards of the ſurface, at leaſt in the diſtrict I inhabit, it may be ſuppoſed to be affected by the influence of the ſun during ſummer, and the ſevere froſt in winter. To avoid, then, as much as poſſible, both theſe cauſes of error, I have choſen for the time of my experiment, what, in my opinion, is the moſt favourable of the whole year, *viz.* the ſhort interval which takes place between the rigorous ſeaſon of winter and the heat of ſummer, when the water is moſt exempt from either influence. The epoch fixed upon then for my experiment was the 9th of May, whilſt we had ſtill a little floating ice in our river, the laſt of that which comes down from the lake Ladoga every ſpring on its breaking up. At this time, the trees were ſtill without a leaf, except the birch, which was juſt budding; and REAUMUR's thermometer ſtood at $10°\frac{1}{2}$ above the freezing point, ſome degrees higher than it had yet done; ſo that I think, from the ſmall effect the ſun had yet produced on vegetation, *&c.* we cannot well ſuppoſe, that the temperature of a thick covered well in my garden, excluded as much as poſſible from communication with the open air, by every precaution I could invent, could be ſo much affected by it, as to produce an error on the ſide of heat.

May

May 9. Heat of the air, 10°½ above o.
Heat of the well in my garden, Imp. Cadet Corps, 2°¼ above o.

Now, as the mean heat of our climate is 2°$\frac{7}{10}$, there is a very remarkable coincidence between it and the heat of the water, even taken under all the disadvantages mentioned above. However, I by no means offer this as the absolute and exact temperature of deep wells and springs in this province, which may certainly be considerably different.

THE mean heat of the only four countries determined in this manner, that have fallen under my cognisance, make a short but curious scale, as they are of temperate, torrid, and frigid climates. As for example:

			Mean heat of the climates.	Heat of wells and springs.
St Petersburg,	N. Lat. 59° 26′ 23″	Long. 30° 25′ E. from the first merid. of Greenw.	2°$\frac{7}{10}$	2°¼
London,	N. Lat. 51° 31′	Long. 0	7°¼	7°¼
Paris,	N. Lat. 48° 50′	Long. 2° 25′ E.	10°	10°¼ in the cave under the observatory.
Kingston, Jam.	N. Lat. 18° 15′	Long. 76° 38′ W.	21°¾	21°¾

THE difference of temperature between London and Paris is more remarkable than their distance will account for, and, of course, is an illustration of the effect of insular situation, which was my reason for setting down two places so near to one another. Accident sometimes presents us with one interesting fact when in search of another. This was my case, in taking the heat of the earth in my garden, to contrast with that of my well, for a particular purpose. On April 19. 1789, REAUMUR's thermometer at 7° above o, I found the heat of the earth, in a soft bed one foot from the surface, only half a degree above the freezing point, and on the next day was astonished

niſhed to find it at 5° above it, although the thermometer in air had not altered its poſition, but was ſtill at 7°, nor had the ſun ſhone out in the interval, ſo that this ſurpriſing change of heat in the earth ſeems to have been effected by a ſhower of rain that fell between the two obſervations; a ſtrong confirmation of the hypotheſis that rain water contains a large portion of latent heat, and probably of electric matter; ſo that it is not ſurpriſing, if plants ſhould, under certain circumſtances, ſtart, as it were, ſuddenly out of the earth after a ſhower of rain, as they receive ſo large a ſupply, not only of moiſture, but likewiſe of heat, and poſſibly a vivifying principle from the ſtimulus of the electric fluid carried down by the rain.

General Obſervations on the Summer Atmoſphere.

The ſtate of the atmoſphere during the ſummer, is in general pretty fixed, and the air very ſerene and clear, both during the day and night, in ſpite of the heavy dew that falls from the ſetting to the riſing of the ſun, which ſeems to ſerve, as before obſerved, for watering the plants during this hot dry ſeaſon. I have been much ſtruck with obſerving, that an excellent hygrometer, ſent me by the learned Profeſſor Pictet of Geneva, (hung within doors with the windows open) indicated a greater degree of humidity, on a fine ſummer evening, than during the moſt continued rainy weather; ſo much higher is the ſaturation of the air with water, and ſo much greater is its diffuſion through it, than when it falls in the form of rain. This obſervation favours the modern hypotheſis of the chemical ſolution of water in air.

I think alſo worthy of remark, the much greater effect this ſultry debilitating period has upon foreigners, (from even warm countries) than on the natives of the north, as one ſhould naturally think the former would ſupport it better, than a people unaccuſtomed, for ſo long a period of the year, to exceſſive

ceſſive cold. This, however, is by no means the caſe; for whilſt foreigners can ſcarcely take any exerciſe out of doors, with the ſun high above the horizon, without feeling a ſpecies of faintiſh debility, the natives even carry on the hardeſt labour without much apparent fatigue. This may probably be accounted for by their conſtant uſe of the vapour bath, heated to a degree unſupportable for many minutes to a foreigner, whilſt they feel themſelves perfectly at their eaſe in it, from habit, and are as fond of it as the Greeks and Romans were of the tepid water bath.

ANOTHER circumſtance in the mode of life of this northern people, which may alſo contribute greatly to their ſupporting ſo well conſiderable degrees of heat, is their living at home, for eight months of the year, in a conſtant heat of from 16° to 20° of REAUM. or from 68° to about 77° of FAHR.; nay, even during the ſummer, the ovens of their cottages are obliged to be pretty conſtantly heated, each peaſant baking his bread at home, and dreſſing his victuals in them.

AUTUMN.

THE remark I have already made on the ſeaſons will account for my leaving this period blank, and only mentioning it for form's ſake. I have annexed the abridged regiſter of fifteen years, made uſe of in this paper, as there may be ſome who would wiſh to ſee it.

TWO LETTERS *on* ELECTRICAL *and other* PHENOMENA; *addreſſed to* Dr *MATTHEW GUTHRIE, Conſ. Aul.* F. R. SS. LOND. and EDIN. *Phyſician to the Imperial Corps of Noble Cadets, and to that of the Artillery and Engineers in St Peterſburg, by his Excellency M. ÆPINUS.*

[*Tranſlation from the French.*]

DEAR SIR,

I ACKNOWLEDGE the pleaſure I have received in peruſing your paper on the Northern Climate; and certainly it would be difficult to give, with more method and intelligence, a clear and diſtinct idea of the peculiarities of our climate, *quod malus Jupiter urget*, and which diſtinguiſh it from the other countries of Europe, placed under a more mild and temperate ſky.

I SHALL therefore comply with pleaſure, in giving a circumſtantial account of the curious facts mentioned in your Diſſertation, as ſeen and authenticated by me; and ſhall, at the ſame time, avail myſelf of your permiſſion to communicate the remarks and reflections I have made on reading your intereſting Diſſertation *.

THE uncommon phenomena alluded to in your paper, were as follow: During the laſt weeks of the year 1766 and the firſt of 1767, we had conſtantly very ſtrong froſt, with the calm,

* Dr GUTHRIE ſolicited the learned gentleman's remarks and opinion on his paper. M. ÆPINUS is the oldeſt Profeſſor of the Imperial Academy now alive, having ſpent upwards of thirty years in this country; and as Natural Philoſophy was his profeſſional line before called to Court, and his amuſement ſince, his Excellency is of all others moſt able to judge of the peculiarities of our climate, and the fitteſt to put the ſtamp of veracity on this Diſſertation, its principal merit.

calm, clear and ſerene ſky which generally accompanies it in this climate; and during its prevalence, her Imperial Majeſty having ſent for me one morning, ordered me to go to the apartments of Prince ORLOFF, in another part of the palace, who, ſhe ſaid, had, for ſome days paſt, become uncommonly electric every time his hair was combed.

I FOUND the Prince at his toilet, and obſerved, in fact, that, at every time his valet de chambre drew the comb through his hair, a pretty ſtrong crackling noiſe was heard; and on darkening the room, by drawing the curtains, the ſparks were ſeen following the direction of the comb in great abundance, whilſt the Prince, by this operation, was become ſo completely electric, that ſtrong ſparks could be drawn from his hands and face; nay, he was even electrified when he was only powdered with a puff, the friction of the air againſt his hair being able to produce a conſiderable degree of electricity; a curious experiment, which however but ſeldom ſucceeded afterwards, when I was deſirous of repeating it.

A FEW days after this ſcene with the Prince, I was witneſs to a ſtill more ſtriking effect of the electric ſtate of our atmoſphere at this period. His Imperial Highneſs the Grand Duke ſent for me one evening in the twilight, and told me, that, having briſkly drawn a flannel cover off a green damaſk chair in his bed-chamber, which had been put on it by accident, he was aſtoniſhed at the appearance of a ſtrong bright flame that followed it; but having immediately comprehended that it muſt have been an electric phenomenon, his Highneſs had been trying to produce a ſimilar illumination on different pieces of furniture, and could now ſhow me a beautiful and ſurpriſing experiment, that he had juſt diſcovered.—His Highneſs then threw himſelf on his bed, which was covered with a damaſk quilt laced with gold, and rubbing it with his hands in all directions, the young Prince, who had then reached his twelfth year, appeared to be ſwimming in fire, as, at every ſtroke,

gg 2 flames

flames arofe all around him, which, darting to the gold lace border, run along it, and up that of the bed, to the very top.

WHILST his Highnefs was fhowing me his experiment, Prince ORLOFF, who had been making many different trials of his perfonal electricity, fince the day I faw him at his toilet, came into the room with a fable muff in his hand, and fhowed us, that, by only whirling it five or fix times round his head in the air, he could electrify himfelf fo ftrongly, as to fend out fparks from all the uncovered parts of his body; another proof that the fimple friction of air againft hair could produce electricity. Similar experiments were repeated in many houfes of the city, whilft the ftrong froft prevailed; which fhows, that the uncommon difpofition of bodies to electricity, during the period treated of, was general.

THESE curious phenomena have appeared from time to time fince that epoch, particularly during the fevere cold which has prevailed for thefe four weeks paft. A few days ago, a lady of my acquaintance informed me, that, on having her head combed, not only her hair fhowed the ordinary figns of electricity, but that, after the comb had been drawn through, it bufhed out in a moft furprifing manner, by the mutual repulfion of the hairs, and occafioned, on rifing upon her head, a moft fingular and difagreeable fenfation, which would certainly have frightened her terribly, if fhe had not inftantly gueffed the caufe.

IT muft not, however, be taken for granted, that thefe appearances are quite common here, or that they appear every winter, although we never fail to have 24° and upwards of cold, by REAUMUR's fcale. No; to render thefe effects very remarkable, a great cold muft have continued feveral weeks without abating, as I fhall explain in the fequel.

I SHALL here likewife account for a curious fact mentioned above, which muft have drawn the attention of the reader, *viz.* that Prince ORLOFF became electrified whilft fitting at his toilet,

toilet, on a chair placed on the bare floor, or on walking in the Great Duke's apartment, without any ſpecies of apparatus to cut off his communication with the naked boards; but he was in fact inſulated in both ſituations, as the inlaid floors were become as completely ideo-electric as glaſs or roſin, from the high dried ſtate to which they were reduced by an exſiccating quality of the atmoſphere, (to be explained in the ſequel) and conſtant waxing. Now, as I obſerve, Sir, that in your paper on our climate, you enter into ſome reaſoning on theſe phenomena, I preſume my opinion on them will not be diſagreeable to you.

The great diſpoſition, then, of air, and other bodies, to become electric, during great degrees of cold continued for a certain time, always appeared to me to be ſo eaſily explained, that I looked upon it as a ſimple corollary of the beſt known of the laws of electric force, and as ſuch, that it did not require to be deduced from it in a formal manner. However, that you may know on what I founded that ſuppoſition, I ſhall obſerve, That, *firſt*, nothing indicates air, and other bodies, to contain, during ſevere froſt, an atom of more electric matter than their natural quantity; and they are certainly not in a ſtate of ſpontaneous electricity, becauſe, to render them electric, friction muſt be employed, as at all other times; ſo that all the uncommon appearances above mentioned are reduced to this, That, by means of friction, bodies, in the above ſtate of the atmoſphere, become more eaſily, and more ſtrongly, electric, than at any other time, which does not indicate a larger quantity of electric matter, but a greater diſpoſition to receive it.

2dly, There is no neceſſity, then, to enquire, why air, ſilk, wool, hair, wood, *&c.* contain a greater quantity of electric matter in this than in another ſeaſon, ſince the fact does not obtain; ſo that the queſtion left for inveſtigation is only, Why they poſſeſs, during ſevere cold, a greater aptitude or diſpoſition

to

to become electric, than in any other ſtate of the atmoſphere? or, in other words, Why they become, in a more eminent degree, ideo-electric?

3dly, AIR poſſeſſes, like the other fluids we call *menſtrua*, the power of diſſolving different bodies, eſpecially water, which laſt proceſs we term evaporation; and, like the other menſtrua, this power is modified by the degree of heat it poſſeſſes, ſo that, *cæteris paribus*, warm air can diſſolve, and hold in ſolution, a much greater quantity of water than cold air.

4thly, SUPPOSE that air, heated to a given degree, holds in ſolution as much water as it is able to diſſolve, that is to ſay, that it is ſaturated with it, and it then cools down ſo conſiderably, that it cannot hold in ſolution the ſame quantity it did at firſt; there ſhould, in that caſe, take place a large precipitation, or a large portion of the diſſolved water ſhould ſeparate itſelf from the cooled air; ſo that it muſt remain charged with a much ſmaller quantity than before it loſt its heat.

5thly, IT follows, then, that the atmoſphere is never drier than during great froſt, and never more humid than during great heat; and this aſſertion will appear a paradox only to thoſe who confound a dry with a drying air, and a wet with a wetting air; or who do not reflect that a dry air may not be of a drying nature, and that a humid atmoſphere may not be of a wetting quality. I hope, likewiſe, nobody will maintain, that the apparent purity, and perfect tranſparency of the air, in a fine ſummer day, is a proof of its not being charged with heterogeneous matter, as that tranſparency is only the effect of a perfect ſolution of the water it contains.—It is evident, by the common chemical operations, performed every day, that every perfect ſolution is clear and tranſparent, and that when it becomes turbid, a precipitation is at hand. Let us confirm this fact, Sir, by a phenomenon we have an opportunity of ſeeing very often in ſummer, *viz.* that we ſhall find the air full of broken

broken clouds in the morning, which vaniſh under our eye whilſt looking at them, as the ſun riſes higher above the horizon, in the ſame manner as chemical ſolutions become turbid on cooling, and clear again on heating.

6thly, THIS extraordinary dry air penetrates into our apartments, either gently and inſenſibly through chinks, or rapidly and perceptibly when our ſtoves are lighted each morning; a ſure means of renewing the air of our apartments once in twenty-four hours at leaſt. The external air thus introduced, ſoon acquires the temperature of the chamber, which is commonly from 12° to 15° or more of REAUMUR, (in the better ſort of houſes, for thoſe of the common people are warmer) and then recovers its diſſolving power, which the ſeverity of the cold had conſiderably diminiſhed, nay almoſt entirely overcome; but as it now contains little or no humidity, it muſt, like other *menſtrua*, attack the humidity that it finds in the chamber, with a much greater rapidity than it could have done with the ſame degree of heat, had it not been thus purified (or dephlegmated, in the language of chemiſtry) by the cold. All the bodies, then, which happen to be in the room, muſt loſe of their humidity, or be dried much quicker than in any other ſeaſon; and, in fact, there is no houſekeeper in Peterſburg who does not perceive to his coſt this extraordinary drying proceſs, as our furniture warps, cracks or ſplits much more during the rigour of winter, than in the hotteſt period of ſummer, nay probably more than in any other country between us and the equator.

7thly, A NATURAL reſult of all this, is, that, after our great cold has continued a certain time, the bodies mentioned above, *viz.* air, ſilk, wool, hair, wood, *&c.* are in fact, without aſſiſtance from us, drier than during the reſt of the year, and probably more ſo than in any other part of Europe, except they are dried expreſsly by ſome artificial means.

8thly,

8thly, Now, the bodies I have enumerated, are all in the claſs of imperfect ideo-electrics, and have likewiſe the common property of attracting moiſture, ſo that they can never be perfectly dry; but water is, after the metals, the moſt perfect conductor of the electric fluid, or the leaſt of an ideo-electric, I ſay, after the metals; for I think I have obſerved, and probably others have done the ſame, that water does not conduct quite ſo well as they do. But let that be as it may, theſe bodies cannot certainly imbibe water without becoming leſs of an ideo-electric, in proportion as they do ſo, and, of courſe, the more they dry again, the more they recover their natural quality.

THE reſult upon the whole then muſt be, That during our ſevere cold, the bodies of which I ſpeak become ſpontaneouſly much better ideo-electrics here, than they ever are in any other ſeaſon or climate; therefore theſe bodies have an extraordinary diſpoſition to become eaſily and ſtrongly electric.

IT cannot have eſcaped your penetration, Sir, that in all I have ſaid, I have advanced only known and generally received facts, without admixture of hypotheſes or conjecture of my own; ſo that the explanation I have given of the phenomena, (alluded to in your paper, and which I was called upon to illuſtrate) ariſes naturally and neceſſarily from thoſe facts, in ſuch a manner, that it may paſs, in my opinion, for a demonſtration, ſuch as is to be given in Natural Philoſophy.

IT appears to me then, Sir, that we are not obliged to have recourſe to the conjectures of Meſſrs SAUSSURE, BERGMAN, WILKE, &c. to explain the above phenomena, as you appear to have been diſpoſed to do, in the paſſage alluded to, with a moderation that does honour to your mode of philoſophiſing; nay, if we were even inclined to employ them, I do not ſee how they would anſwer our purpoſe, being only hazarded opinions; but could they be verified, (which I doubt much) they would even then be of very little uſe, as they could contribute nothing to the perfection of the theory of electricity.

YOU

You must excuse me, Sir, if I enter into another discussion which the same passage of yours has likewise given rise to. I mean, the opinions which several of the learned have thrown out of late years relative to two sorts of electricity.

It was I, Sir, as you know, who first gave rise to that idea many years ago. I had proved, in my *Tentamen Theor. Electric. et Magn.* that the portions of matter belonging to every body in nature, repel one another. This proposition appeared bold to some of the learned, as indeed it would have done to myself, before I had well examined, digested and compared it with the analogy of nature.

The Philosophers you cite imagine they could remove this difficulty, by supposing the existence of two distinct electric fluids, one of which is positive and the other negative. I shall confine myself at present to a few remarks upon that subject.

1mo, Those who would pass that idea for a new theory of electricity different from mine, (and there are those who attempt it) have not considered matters in their true point of view; for it is evident that a theory, founded on the supposition of two fluids, will coincide perfectly and essentially with mine; nay, the explanation of the phenomena, the reasoning, and even the analytic formula which they draw from their pretended theory, is exactly the same as mine. But supposing their hypotheses could be proved, there would result from it nothing new, except that it might furnish an explanation of one of the fundamental facts on which I founded my theory, and which I did not follow, nor think important enough to investigate the origin of, but was contented to admit it as an established fact.

2do, My theory, in confining itself to simple well attested facts, neither assists nor denies the existence of two, or even several fluids, which nature might possibly employ to effect the fundamental laws on which I have established my theory; for when I make use of the expression *matter proper to bodies*, it is evident, that it means what remains in a body after we have drawn off the electric fluid.

3tio, In consulting the analogy of nature, one cannot fail to recollect, that all known bodies possess, besides the Newtonian attraction, which is common and general to them all, another attractive force, or that which produces cohesion between two pieces of polished marble, the ascent of fluids in capillary tubes, and an infinite number of other phenomena. Now, this last attractive force is evidently and essentially different from the first; for whilst the one follows the inverse ratio of the square of the distance, it is proved that the other is in proportion to a power, into which enters the reverse ratio of the cubes, and probably of some still higher power of the distance.

If then both experience and the analogy of nature, show the possibility of the co-existence of two attractive forces in the same body, governed by laws entirely different; and as a repulsive force is nothing else than a negative attractive one, my supposition of the repulsive force of bodies, contains nothing but what is perfectly conformable to the analogy of nature.

You also make mention, Sir, and with reason, of the frequent appearance of the beautiful phenomena of parheliums and mock moons in our climate, which enables us to be better acquainted with all the circumstances attending them, than people nearer the equator. I paid a particular attention to these phenomena for a part of the years 1758 and 1759, and I think I have made some important observations on that subject; but it is not at present either the time or place to enter into them, especially as I have already given the principal facts in a paper inserted in the eighth volume of the Novi Comment. Academ. Scien. Petrop. p. 392, by referring to which I shall content myself at present.

It is now time, Sir, to finish this long letter, which has almost swelled to a dissertation; and I shall do so, by assuring you, that I am, with much esteem,

Your obedient servant,

St Petersburg,
Jan. 7—18. 1789.

Æpinus.

SIR,

S I R, *January* 23. 1789.

An idea has ſtruck me ſince I ſent off my laſt letter, which may poſſibly merit your attention, and therefore I ſhall give it you.

Both of us know long ago, Sir, and we have probably felt it lately, that when a ſevere froſt has laſted for a certain time without intermiſſion, we may in vain ſtrive to prevent feeling its effects on our own bodies, as well as our furniture, although we even remain within doors in a comfortable ſpring heat, without expoſing ourſelves to the open air at all. It might be ſuppoſed that theſe precautions would be ſufficient; but they are in fact far from being ſo: for as ſoon as the ſevere cold has laſted ſome time, we find ourſelves attacked with a diſagreeable ſenſation, which, like all the reſt of our ſenſations, there is no deſcribing exactly. I ſhall therefore only ſay, that it conſiſts in a ſort of laſſitude and heavineſs or torpor, affecting both the body and mind, joined to a troubleſome reſtleſſneſs or inquietude. Such are our feelings during the continuance of the above deſcribed weather, and I ſhall next give you, Sir, my conjectures on the cauſe of this curious phenomenon.

In the letter I had the honour to write you ſome weeks ago, I proved, that great cold renders the air dry and pure in a moſt aſtoniſhing degree, and that the heat which it afterwards receives in our apartments, renders it drying in a proportion equally ſurpriſing. Now, is it not poſſible that it is this ſame drying quality of our chamber-atmoſphere which produces the ſenſations enumerated above? For why ſhould it not attack, under the ſame circumſtances, the human body, as well as our wooden furniture, and all other bodies which happen to be in the rooms? Surely, what we call perſpiration muſt be much increaſed by it; and this conſumption of our excreted fluids may poſſibly be extended, I ſhould think, to the nobler fluids neceſſary

neceſſary to the functions of the animal œconomy, ſuch as what are called vital ſpirits, the exiſtence of which is ſuppoſed, with ſome degree of probability, without our being able to ſay what they are. This idea appears the more likely, as it is known that the diſſolving power of air is not confined to water alone, but is extended to many other bodies. If then my conjecture is founded, there appears to me, Sir, a very eaſy way to prevent this ſort of diſeaſe; for in fact it is one, although but ſlight and of little conſequence; we have only to give back to the air the humidity which the froſt had robbed it of, which may be done, either by promoting the evaporation of a certain quantity of water in the room, or, what will be a much more convenient and ſhorter mode of doing it, to hang up a cloth of a proper ſize, dipped in water, and wetted from time to time.— I ſubmit, Sir, theſe conjectures to your judgment; as all that regards the impreſſion which, in length of time, may be made on the human body, by a very dry and a very drying air, falls more immediately into your line as a Phyſician, than into that of your moſt obedient ſervant,

Æpinus.

You may make what uſe you pleaſe of this letter, and give it the ſame deſtination as the firſt, if you think proper.

END OF PAPERS OF THE PHYSICAL CLASS.

The MEAN STATE of the ATMOSPHERE in St Peter
Weather, kept by Professor EULER, perpetual Secretary to the Imperi

For the six Winter Months, November, December, January, February, March and April, which make 181 days of the common year.

I. B A R O M

At 20 feet above the mean level of the Neva, and at 6000 feet from its falling into the Gulph of Finland.

At higheſt,	28.87	commonly in January.
At loweſt,	26.99	ofteneſt in November.
Difference,	1.88	The mean between theſe extremes, 27.93.
Mean height,	28.02	Paris inches.

It ſtands 95 days above 28 inches, and 86 days below it.

II. T H E R M

DE L'ISLE's Thermometer in the ſhade, and expoſed to the north, th

Greateſt cold,	196°	commonly in January, equal to 24° below 0 of FAHRENHEIT, or $24^{\circ}\frac{1}{2}$ of REAUMUR below 0.
Leaſt cold,	141°	in November or April, equal to 57° of FAHR. above 0, or $5^{\circ}\frac{1}{2}$ of REAUM. above 0.
Difference,	55°	equal to 64° of FAHR. or $28^{\circ}\frac{3}{4}$ of REAUM.

Mean cold of the night, 162° equal 23° of FAHR. above 0, or equal 7° of REAUM. below 0. And of the afternoon, 154° equal 27° of FAHR. above 0, or equal 2° of REAUM. below 0.

The cold has been above 170° for 47 nights, equal to 8° of FAHR. above 0, or equal to $10^{\circ}\frac{2}{3}$ of REAUM. below 0. And above 150°, or the freezing point, for 156 nights.

The mean term of the firſt froſt, the 9th October, new ſtile.

The mean term of the Neva freezing, the 27th November.

III. W I

Perfect calm,	28 days.			Light breezes,	87 days.		
Briſk gales,	50 days.			Strong gales,	16 days.		
N.	14 days.	E.	23 days.	S.	20 days.	W.	45 days.
N.E.	19 ——	S.E.	12 ——	S.W.	22 ——	N.W.	26 ——

IV. S K Y AND A T

Sky clear,	39 days.	Cloudy, 68 days. Overcaſt, 74 days.
Fog,	26 ——	
Rain,	20 ——	
Snow,	64 ——	Mean term of the firſt ſnow, Oct. 9. N.S.

Quantity of rain and melted ſnow, $4\frac{27}{100}$, or about 5 inches.

Aurora Borealis,	16 or 17 days.
Tempeſt,	ſeldom.
Hail,	very ſeldom.

: Peterſburg, for Sixteen Years, extracted from a Regiſter of the Imperial Academy of Sciences.

For the ſix Summer Months, May, June, July, Auguſt, September and October, which make 184 days of the year.

O M E T E R.

g

N. B. The ſcale of the barometer is divided into Paris inches and hundredth parts.

At higheſt,	28.47	ofteneſt in May or October.
At loweſt,	27.50	ofteneſt in September or October.
Difference,	.92	The mean between theſe extremes is 27.96.
Mean height,	28.04 Paris inches.	

Its height for 107 days is above 28 inches, and for 77 days below it.

M O M E T E R.

north, the inſtrument in uſe in the Imperial Academy of Sciences.

Greateſt heat,	106°	commonly in July or Auguſt, equal to 85° of FAHR. above 0, or to $24°\frac{1}{2}$ of REAUM. above 0.
Leaſt heat,	144°	in May or October, equal to 41° of FAHR. above 0, or to 3° of REAUM. above 0.
Difference,	38°	equal to $46°\frac{1}{2}$ of FAHR. or equal to $20°\frac{1}{2}$ of REAUM.

Mean heat of the afternoon, 127°, equal to 59° of FAHR. above 0, or equal to 12° of REAUM. above 0. And of the night, 136°, equal to 49° of FAHR. above 0, or to $2°\frac{1}{2}$ of REAUM. above 0.

The heat of the afternoon has been 130°, equal to 56° of FAHR. above 0, or $10°\frac{3}{4}$ of REAUM. above 0; and above 150° for 182 days: That is to ſay, that the thermometer has been ſo many days above the freezing point.

The mean term of the laſt froſt, 3d of May, new ſtile.

The mean term of the opening of the Neva, 19th of April.

I N D.

Perfect calm,	41 days.			Light breezes,	75 days.		
Briſk gales,	53 days.			Strong gales,	15 days.		
N.	32 days.	E.	19 days.	S.	22 days.	W.	27 days.
N. E.	15 ——	S. E.	18 ——	S. W.	24 ——	N. W.	27 ——

A T M O S P H E R E.

Sky clear,	53 days.	Cloudy, 87 days.	Overcaſt, 44 days.
Fog,	17 ——		
Rain,	80 ——		

Snow, from 6 to 7 days. Mean term of the laſt ſnow, 4th of May, N. S.

Quantity of rain-water, $10\frac{96}{100}$, or about 11 inches.

Aurora Borealis,	from 8 to 9 days.
Tempeſts,	from 11 to 12 ——
Hail,	from 2 to 3 ——

II.

PAPERS OF THE LITERARY CLASS.

II.

PAPERS OF THE LITERARY CLASS.

I. *An* ACCOUNT *of some* EXTRAORDINARY STRUCTURES *on the Tops of Hills in the* HIGHLANDS; *with Remarks on the Progress of the Arts among the ancient Inhabitants of* SCOTLAND. *By ALEXANDER FRASER TYTLER, Esq; Advocate,* F. R. S. EDIN. *and Professor of Civil History in the University of* EDINBURGH *.

IN the year 1777, an account was published by Mr JOHN WILLIAMS, mineral-engineer, of certain remains of ancient buildings on the summits of some of the hills in the Highlands of Scotland, which had hitherto escaped observation, and which to him afforded grounds for a very extraordinary supposition, That they had been cemented together by means of *Fire*. He mentioned several of those hills exhibiting remains of building, which he had visited and examined; particularly the hill of Knockfarril in Ross-shire, Craig-Phadrick near Inverness, Dun-Evan and Castle-Finlay in the county of Nairn, and the Castle-hill of Finhaven in the county of Angus. He described the vestiges of regular fortifications on the summits of those

* Part of this Paper was read in 1783, before the Philosophical Society of Edinburgh. It is now enlarged, and printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

thofe hills, of which the walls, remaining in fome places of feveral feet in height, were evidently compacted together by the vitrification of the ftones of which they were built; and he offered fome ingenious conjectures with regard to the means employed in forming fuch extraordinary ftructures, and the purpofes for which they might have been reared.

This account, which Mr Williams himfelf candidly owned, was by many people treated as a fiction, excited, however, the curiofity of feveral travellers to vifit and examine fome of thofe hills which he had mentioned. In the fame year, 1777, Dr James Anderson of Monkfhill, tranfmitted to the Society of Antiquaries of London, a very elaborate account of fome ancient monuments and fortifications in the Highlands of Scotland, contained in two letters, which are publifhed in the 5th and 6th volumes of the *Archæologia*. In thefe he treats, at confiderable length, of the vitrified forts, and particularly of that upon the hill of Knockfarril in Rofs-fhire; and, agreeing with Mr Williams in the general idea, that, in rearing thofe ftructures, the builders had employed fire for the purpofe of cementing the materials, he differs from him a little as to the manner in which he fuppofes the fire to have been applied to the mound or rampart.

It is curious to remark, how the fame appearances, to different obfervers, lead to the moft oppofite opinions and conclufions. The two gentlemen above mentioned feem not to have entertained the fmalleft doubt, that the vitrified materials on the tops of thofe hills, were the veftiges of works of art, and the remains of ftructures reared for the purpofes of fecurity and defence. The Bifhop of Derry, when on a tour to the north of Scotland, vifited the hill of Craig-Phadrick near Invernefs, and expreffed his opinion, that the mounds of vitrified matter were not the remains of any artificial work, but the traces of an ancient volcano. In the Philofophical Tranfactions of the Royal Society of London for 1777, Part II. No. 20. is an ac-

count

count of *Creck Faterick*, there termed *a volcanic hill near Invernefs*, in a letter from THOMAS WEST, Efq; to Mr LANE, F. R. S. in which the writer does not hefitate to pronounce this hill an extinguifhed volcano; and having fent fpecimens of the burnt matter for the infpection of the Royal Society, the Secretary fubjoins a note to the paper, intimating, that " thefe fpecimens " having been examined by fome of the Members well ac- " quainted with volcanic productions, were by them judged to " be real lava." Such was likewife the opinion of a very inge- nious Member of this Society, the late ANDREW CROSBIE, Efq; who, in an account which he gave to the Philofophical Society of Edinburgh in 1780, offered fome curious conjectures with regard to the procefs of nature, by which he fuppofed the whole of this hill to have been thrown up from the bottom of the fea by the operation of inteftine fire.

THE perufal of Mr WILLIAMS's pamphlet and of Dr ANDERSON's account, as well as thofe differing opinions I have mentioned, excited my curiofity, in a journey I made to Invernefs-fhire in autumn 1782, to examine, with fome attention, fuch of the hills mentioned by Mr WILLIAMS as lie in that country; and I now propofe to lay before this Society the refult of that examination, which, however, I confine chiefly to Craig-Phadrick, as that which I have moft minutely furveyed.

CRAIG-PHADRICK is a fmall conical hill, which forms the eaftern extremity of that ridge of mountains which bounds Loch-Nefs upon the north-weft fide. It is fituate about a mile to the north of Invernefs, and commands an extenfive profpect of both fides of the Murray frith, to the diftance of above forty miles. It is acceffible on two different quarters; on the weft by a narrow but level ridge, which joins it to the chain of hills upon Loch-Nefs; and on the fouth-eaft, by an eafy afcent from the high ground above the town of Invernefs. When feen from the oppofite heights, it appears pretty much of a conical figure; the top cut off, forming a level furface, bounded at each

each end by a ſmall riſing or ſhoulder. At the diſtance of three or four miles, its artificial appearance is more perceptible than upon a nearer approach, when the eye, ſeeing only a part, fails to take in the great outlines, and to perceive their regularity and ſymmetry. A more diſtinct idea of the general form of this hill than can be given by deſcription, may be obtained from a ſketch taken from the oppoſite high grounds, at a few miles diſtance. See Plate I. fig. 1. In this ſketch, Craig-Phadrick is marked by the letter C. B are thoſe hills, a part of the ſame ridge, which bound Loch-Neſs upon the north-weſt; and D is a conical hill oppoſite to Craig-Phadrick, on the other ſide of the Murray frith.

On approaching Craig-Phadrick from the level ridge upon the weſt ſide, what firſt preſents itſelf to view is a road cut through the rock, from the bottom to the ſummit; in moſt places about ten feet in breadth, and nearly of the ſame depth, winding in an eaſy ſerpentine direction for about ſeventy feet; by which means an aſcent is gained over a very ſteep rock, which is otherwiſe quite inacceſſible from that quarter. See Plate I. fig. 2. The form alone of this road leaves little room to doubt of its being an operation of art. I examined the ſides of it, where it is cut into the rock, to ſee if there were any marks of a tool. A labourer, who attended me with a mattock, or quarryman's pick, declared his opinion, that, in many places, there were marks of an inſtrument ſimilar to what he had in his hand; but the rock being compoſed of many rounded pebbles, and when broken preſenting a ſurface, in which the beds of thoſe pebbles have often an appearance like what is made by the ſtroke of a tool, I lay little weight upon that circumſtance. The form alone of this road, as I have already ſaid, was ſufficiently convincing to me of its being an operation of art.

From the nature of the ſtone itſelf, of which this hill is formed, and from that compound appearance of water-worn pebbles, ſticking in a cementing maſs, it has been conjectured, that

that theſe pebbles, together with the bed in which they are lodged, had been forced up from the bottom of the ſea, by internal fire ſtruggling for a vent, which it afterwards obtained at the ſummit. With regard to the nature of the ſtone of this hill, I ſhall here obſerve only, that this compound appearance in the rock at Craig-Phadrick, affords no more preſumption of this particular hill being forced up by fire from the bottom of the ſea, than it does of all the ſurrounding hills for many miles having the ſame origin. The greateſt part of the hills which bound Loch-Neſs, both on the north and ſouth, are compoſed of the ſame materials, or at leaſt contain large ſtrata of the ſtone I have mentioned. Yet none of thoſe hills that I have ſeen, or on enquiry have ever heard of, exhibit the ſmalleſt appearance of the effects of fire; though, being infinitely higher than Craig-Phadrick, and conſequently demanding a much greater force to raiſe them up, had fire been the agent, its effects on them would probably have been much more conſpicuous than on a hill incomparably ſmaller.

THAT the materials which compoſe the hill of Craig-Phadrick, as well as all other hills, of which the ſtone is of a ſimilar nature, have originally been under water, I have not the ſmalleſt doubt. The compound appearance of the rock, which is evidently a maſs of water-worn pebbles, of various ſize, nature and colour, ſticking in a bed of clay, leaves no room to doubt of its origin. But whether thoſe hills, which conſiſt of ſuch compound materials, have been forcibly raiſed up from the bottom of the water, by ſome convulſion of nature, or formed by a gradual *alluvio*, or depoſition of materials under a maſs of water which has now deſerted them, (as ſand-banks are formed in the ſea) is what we have no grounds for determining with certainty, and few to found even a probable conjecture: Since, with regard to this particular hill, there never has been a ſection made acroſs any part of it, from which the component ſtrata might be perceived, or the diſpoſition in which

which they lie. All that I am at preſent concerned to ſhew, is, that, from the ſuperficial or external appearance of this hill, there is no reaſon for ſuppoſing that it ever contained inteſtine fire.

THE ſtone, of which the whole of this hill, and moſt of the neighbouring hills are compoſed, is a mixed maſs of round water-worn pieces of different coloured granite, greyiſh or ſpeckled quartz, and the common white quartz. This compound ſtone, which is well known to miners, has, from its appearance, been termed *plum-pudding* ſtone. Thoſe who have entertained the notion of Craig-Phadrick's being an extinguiſhed volcano, have maintained, that this compound ſtone is of the nature of the volcanic *tufas*. This, however, will be acknowledged to be a miſtake, by all who have examined and compared the two ſubſtances. The volcanic tufas are all compoſed of materials which have undergone a change by fire; the plum-pudding ſtone has undergone no ſuch change. Sir WILLIAM HAMILTON deſcribes tufa to be a ſoft ſtone, compoſed of pumice, aſhes and burnt matter, its colour often tinged with grey, green and yellow. It is formed, ſays he, by water making up theſe materials into a ſort of clay, which afterwards hardens. The plum-pudding ſtone, on the contrary, contains no burnt materials. Its component parts, ſo far from being already burnt, when expoſed to fire, undergo a total change, and the whole ſtone ſuffers an imperfect vitrification. Upon the whole ſurface of this hill, and amidſt all the detached fragments, both of the natural ſtone and of the vitrified matter, there is not, ſo far as I could obſerve, any thing that bears the appearance of a pumice ſtone. The burnt matter, indeed, is often full of ſmall holes or honey-combed; but it ſtill retains a glaſſy appearance and a conſiderable weight, both which circumſtances ſufficiently diſtinguiſh it from pumice. *Baſaltes* are, I believe, conſtantly found, in ſome form or another, upon all volcanic hills; but neither on the rock of Craig-Phadrick, nor on any of the neighbouring

bouring hills is there, ſo far as I could obſerve, the ſmalleſt appearance of that kind.

The vitrified matter on the ſummit of this rock is, therefore, the only circumſtance which poſitively vindicates the effect of fire; and this I ſhall now proceed to examine.

The Society have already had before them ſpecimens of this burnt or vitrified matter. I ſhall, therefore, ſuppoſe, that they are ſufficiently acquainted with its appearance. It will be recollected, that in none of the ſpecimens which were produced, was there any thing like a total fuſion of the materials. Some parts of the maſs ſeemed to be portions of argillaceous and unvitriable ſtone; others of ſtones of which a part had been in fuſion, while the reſt remained in its natural ſtate. Theſe circumſtances, of themſelves, are ſufficient to diſtinguiſh this ſubſtance from volcanic lava, which is an uniform homogeneous maſs, of which every part has been in a ſtate of fuſion. Neither has this vitrified ſubſtance the appearance of thoſe *ſcoriæ* thrown up from volcanos, which are probably the ſcum of the lava, or ſuch parts of the materials as either never were fuſible, or have loſt their fuſibility and principle of inflammability: For the burnt ſubſtance on the top of Craig-Phadrick is rather a mixture of fuſible with unfuſible ſubſtances; many parts appearing to have been in the moſt perfect fuſion, while others have remained in their natural ſtate.

But the circumſtance which, in my apprehenſion, evinces, in the moſt ſatisfactory manner, that thoſe appearances of the effect of fire on the ſummit of this hill, are not the operation of nature, but of art, is the regular order and diſpoſition of thoſe materials, the form of the ground, and the various traces of ſkill and contrivance which are yet plainly diſcernible, though conſiderably defaced, either by external violence, or by the obliterating hand of time. To proceed regularly in examining thoſe appearances of artificial contrivance, I return to that winding road I before mentioned, which is evidently cut

through the rock for the purpofe of gaining an eafy afcent from the level ridge to the fummit, which would otherwife have been impracticable.

In mounting up by this road, and towards the middle of the afcent, there appears a fmall platform overhanging the road, upon the right hand, and inclining, by a very gentle declivity, to the edge of the rock. Upon this platform, and on the very edge and extremity of it, are placed four enormous ftones, which have been evidently guided by art into that pofition; as it is impoffible, fuppofing them to have rolled down, that they ever could have refted in that fituation. The pofture of thefe ftones leaves no doubt as to the purpofe they were intended to ferve. Upon an alarm of danger, the ftrength of a very few men was fufficient to raife thefe enormous ftones fo as to deftroy their balance, and project them into the hollow road, which they would entirely block up, and thus either prevent all accefs, or render the pafs fo difficult, as to be with eafe defended by a few againft any number of affailants. This winding road, with the platform upon the right, may be feen in Plate I. fig. 2. which is a fketch of the top or cone of the hill, as it rifes from the level of the ridge to the weft. Some other large ftones are likewife placed on an eminence to the left of the road, evidently to ferve a fimilar purpofe with thofe on the right, and to block up or defend a hollow channel, by which an afcent might have been attempted, by following the waving direction of the natural furrows of the hill at B, C and D.

On arriving at the fummit of the hill by the winding road, and a few feet below the rampart which crowns the top of the hill, there appears an outward wall furrounding the whole, which approaches on the fides of the hill fo near to the upper rampart, as to leave only a fofsé or trench of ten or twelve feet in width between them; unlefs at the weft extremity, where this outward wall extends itfelf to a greater diftance from the inner rampart, and forms a level platform, of an oblong and fomewhat

ſomewhat ſemi-circular ſhape, about forty yards in length, and fifteen at its greateſt breadth. In Plate II. fig. 1. which is a ground-plan of the whole works upon the ſummit of this hill, the outward wall is marked by the letters P, M, N, X, Q; and at P is the level platform above mentioned. This outward wall is in many places ſo low, as to be almoſt level with the rock, though, in other places, it riſes to the height of two or three feet; but even where it is loweſt, the marks of it may be traced by a line of vitrified matter ſticking faſt to the rock, all along nearly of the ſame breadth, which, in moſt places, is about nine feet. The remains of this wall are ſtrongly vitrified, unleſs in one place upon the north ſide, where, for about ſeventy yards, the rampart is formed only of dry ſtones and earth. The probable reaſon of this I ſhall afterwards mention. It is ſufficient juſt now to obſerve, that the ſtrong natural defence that was afforded on this ſide, by the extreme ſteepneſs of the rock, which is here almoſt perpendicular, ſuperſeded the neceſſity of much artificial operation, there being little hazard that an aſſault would ever be attempted on this quarter.

Every where elſe this outward wall appears completely vitrified; and at the eaſt ſide, where the hill is more acceſſible, and the declivity more gradual, there is a prodigious mound of vitrified matter, extending itſelf to the thickneſs of above forty feet. At the ſouth-eaſt corner, and adjoining to this immenſe mound, is an out-work, conſiſting of two ſemi-circular vitrified walls, with a narrow paſs cut through them in the middle. This appears to have been another, and perhaps the principal entry to the fort. It was neceſſary that there ſhould be two entries; one from the level ridge which joins this hill on the weſt to that chain of which it forms the extremity, the other from the low country to the eaſt. The entry to the weſt was defended in the manner already deſcribed; that towards the eaſt did not admit of a defence of the ſame kind, but was ſecured by three ramparts; and the paſs through the ſemi-circu-

lar out-work was made ſo narrow as to be eaſily defended, or even blocked up with ſtones and earth, upon the ſhorteſt notice of danger.

We come now to the inner wall ſurrounding the ſummit of this hill, and incloſing a level ſpace, of the form of an oblong ſquare, about ſeventy-five yards in length and thirty in breadth, rounded, like the outward wall, at each of the ends. This inner wall is nearly of the ſame thickneſs with the outward one, and is of conſiderable height. There is ſome appearance that it has been armed with four baſtions or turrets; as, at regular diſtances, at thoſe places marked d, d, d, d, (Plate II. fig. 1.) the wall enlarges itſelf conſiderably in thickneſs, in a circular figure, like the foundation of a ſmall tower. Of this, however, the traces are ſo imperfect, that I will not take upon me to ſay whether they may not be entirely an accidental irregularity. In the ſame light I was at firſt diſpoſed to have conſidered the circle C, conſiſting of a number of ſmall *tumuli* of earth, with a ſtone placed in the centre, which I ſuppoſed might have been nothing more than an accidental appearance, till lately, that, from the deſcription of ſome ancient fortifications of a ſimilar kind in Ireland, I find there are, in many of them, circles of ſmall *tumuli*, like what I have mentioned, which are ſuppoſed to have marked the place ſet apart for the chief, as the *prætorium* in the camps of the Romans.

But within this inner ſpace, there are other marks of artificial operation, which are leſs ambiguous. On looking at the ground-plan, (Plate II. fig. 1.) there appears, on the eaſt ſide, a portion of the internal ſpace, marked S, which is ſeparated from the reſt by two ranges of ſtones ſtrongly fixed in the ground, in the form of a rectangular parallelogram. This ſeparation is immediately diſcernible by the eye, from this circumſtance, that the whole of the incloſed ſummit has been moſt carefully cleared from ſtones, of which there is not one to be ſeen, unleſs thoſe that form this diviſion, and the ſingle ſtone

ſtone in the middle of the circle of *tumuli* above mentioned. What has been the deſign of this ſeparated ſpace, is difficult to conjecture. It might, perhaps, have marked the reſidence of thoſe of a higher rank, or ſerved as a temple for the purpoſes of devotion.

TOWARDS the eaſt end of the large area on the ſummit, and at the place marked q in the plan, are the veſtiges of a well, about ſix feet in diameter, which has probably been dug deep into the rock, though it is now filled up with rubbiſh to within a yard of the ſurface.

SUCH are the appearances on the ſummit of Craig-Phadrick, which exhibit, in my opinion, ſuch evident and unambiguous traces of artificial operation, that I cannot conceive a difference of opinion to have ariſen concerning their origin, but from too inattentive and haſty a ſurvey of them, joined to a partiality for thoſe hypotheſes, extremely faſhionable at preſent, which aſcribe a vaſt variety of natural appearances to the operation of ancient volcanos.

OF thoſe fortified hills mentioned by Mr WILLIAMS, I had likewiſe an opportunity of examining two others, the hill of Dun-Evan in the County of Nairn, and the Caſtle-hill of Finhaven in the county of Angus.

ON the ſummit of the hill of Dun-Evan, (of which the name implies that it had been originally a place of defence) there have been two walls or ramparts ſurrounding a level ſpace of the ſame oblong form with that upon Craig-Phadrick, though not quite ſo large. There are likewiſe the traces of a well within the incloſed area; and at the eaſt end, as at Craig-Phadrick, there are the remains of a prodigious mound or maſs of building, much more extenſive than that which we have remarked upon the former hill. In all theſe operations, which, in their form, are perfectly ſimilar to thoſe on Craig-Phadrick, there are not, however, ſo far as I could perceive, any marks of vitrification or the effects of fire. Mr WILLIAMS, in his deſcription of Dun-Evan, ſays, that the vitrified ruins are more

waſted

waſted here than upon Knock-farril or Craig-Phadrick ; but as neither I myſelf, nor two other gentlemen who examined this hill along with me, could perceive the ſmalleſt appearance of vitrification, I am inclined to believe, that, in this inſtance, Mr WILLIAMS's fondneſs for his new diſcovery has a little blinded him in his obſervations. Dun-Evan has, in my apprehenſion, been fortified with walls of dry ſtone and earth ; but theſe of great thickneſs, and very compactly built, as appears by their remains at this day. The entry Mr WILLIAMS ſuppoſes to have been at the eaſt end, where there has been, as already obſerved, a prodigious rampart of ſtones. But in this particular he is evidently miſtaken. The entry has, without doubt, been upon the weſt ſide, where there is a ſerpentine road from the bottom to the ſummit, extremely conſpicuous, which is viſibly continued for a conſiderable diſtance along the low ground at the foot of the hill, and is regularly formed, by filling up hollows and levelling rocky heights which lay in its way.

THE incloſed ſpace on the ſummit of the Caſtle-hill of Finhaven, is of much greater extent than that upon Craig-Phadrick or Dun-Evan. The area is about 140 yards in length, and above forty in breadth. The vitrified remains of a rampart are extremely viſible all around the ſummit, which is cleared of ſtones and levelled, unleſs at one end, where there is a great hollow ſpace ſeparated from the reſt of the area, and probably deſtined excluſively for the keeping of cattle. The remains of ſtructure upon this hill are, in other reſpects, nearly ſimilar to thoſe on Craig-Phadrick and Dun-Evan.

ANOTHER fortified hill, which is not among thoſe enumerated by Mr WILLIAMS, I have likewiſe viſited, and have examined with particular attention. This is Dun-Jardel, a very high hill, which riſes in a beautiful, irregular, conic figure, on the ſouth ſide of Loch-Neſs, about two miles to the eaſtward of the fall of Fyers. The ſummit is acceſſible only on the

ſouth

ſouth ſide by a narrow ridge, communicating with the hills of Stratherrick, of which it terminates a ſmall collateral chain. On every other quarter, the aſcent is almoſt perpendicular; and the baſe of the hill is defended by a very rapid river, which winds along two thirds of its circumference. The incloſed area on the top of Dun-Jardel is an oblong ſquare of twenty-five yards in length and fifteen in breadth. It is, therefore, conſiderably ſmaller than any of the three fortified hills above mentioned; but is, from its ſituation and form, incomparably ſtronger, and muſt, in thoſe periods when it was reſorted to for defence, have been quite impregnable. The area on the ſummit is levelled, cleared of ſtones, and has in it the remains of a well. It is ſurrounded with a very ſtrong wall of dry ſtones, which has formerly been of great height and thickneſs, as may be conjectured from the prodigious quantity of ſtones that has fallen only from one ſide of the fortification, and has reſted upon the level ridge on the ſouth ſide. Thoſe parts of the building on the other ſides which have gone to decay, muſt have rolled down the precipice into the river at the bottom. It is remarkable, that, on aſcending the conical ſummit of Dun-Jardel, there is, upon a ſmall ſhoulder of the hill, about fifty or ſixty feet below the fortification on the top, a circle of large ſtones, firmly fixed in the ground, with a tranſverſe double range of ſtones, extending from one ſide, to ſerve as an avenue or entry to the circle. This is, without doubt, a monument of the ſame nature with thoſe which are termed Druidical Temples, and muſt have been appropriated to the ſame purpoſes; but whether it had any connection with the fortification on the ſummit of the hill, I ſhall not take upon me to determine. It may, however, afford ſome ground, as I ſhall afterwards ſhew, for a conjecture as to the period when thoſe extraordinary fortifications were reared.

IMMEDIATELY oppoſite to Dun-Jardel, on the north ſide of Loch-Neſs, is another conical hill called Dun-Sgrebin, on the ſummit

ſummit of which, as I was informed by a gentleman who reſides in that neighbourhood, there are ſimilar remains of a fortification, compoſed of dry ſtone, like thoſe on Dun-Evan and Dun-Jardel. Mr WILLIAMS mentions a ſmall fortified hill near Fort-Auguſtus, called Tor-Dun, which is plainly diſcernible from Dun-Jardel. Dun-Jardel is diſtinctly ſeen from Dun-Sgrebin; and from the ſituation of the country, this laſt is, in all probability, ſeen from Craig-Phadrick. Craig-Phadrick is plainly diſcernible from Knockfarril, and Dun-Evan and Caſtle-Finlay (a fortified hill in the ſame neighbourhood) from Craig-Phadrick. Thus, there is a chain of ſeven fortified hills, commanding a very large tract of country, over which an alarm could be communicated with the utmoſt celerity; and I think it is not improbable, that, upon a minute ſurvey of the mountainous country, it would appear, that there have been, in ſome former period, chains of communication of this kind through many of the regions in the northern parts of the iſland.

NOR were fortified places of this kind peculiar to the northern parts of Britain. The Honourable DAINES BARRINGTON, in a memoir printed in volume VI. of the Archæologia, affirms, that there are many ſuch ſtructures of dry ſtone upon the tops of hills in Wales, and particularly in Merioneth-ſhire. In Dr BORLASE's Hiſtory of Cornwall, we are informed, that there are the remains of ſimilar ſtructures in that country. Some of theſe the author has deſcribed under the name of Hill-caſtles.

IN Ireland, the remains of ſuch fortifications on the tops of hills, are yet much more frequent than in this country.

HARRIS, in his republication of Sir JAMES WARE's Antiquities of Ireland, in treating of what are called *Danes raths* or *Danes forts*, in that country, deſcribes preciſely ſuch fortifications or ſtructures, as thoſe on the ſummits of the hills we have mentioned, *viz.* conical mounts terminating in an oblong level area, and ſurrounded with the remains of ſtrong ramparts. The

The very general tradition, of attributing theſe fortifications, both in Ireland and in this country, to the Danes, I ſhall afterwards ſhew to be quite erroneous. In a collection of miſcellaneous eſſays towards a natural hiſtory of Ireland, publiſhed by Dr MOLYNEUX, Dr GERARD BOATE, and others, there is an accurate deſcription given of thoſe ſtructures. " Moſt of " thoſe in Ireland," ſays Dr MOLYNEUX, " are ſurrounded only by earthen ramparts. Some, though but a few, are encompaſſed round with walls of ſtone caſt up inſtead of earth, " yet without any mortar. Two of theſe may be ſeen at " Farmoyle in the county of Longford." The authors of the ancient and modern ſtate of the county of Down, deſcribe particularly five of thoſe fortified mounts, which are but a few, out of a vaſt many in that ſingle county. On the *Rath* at Crown-bridge near Newry, there is, at the weſt end of the level area, and about fifty feet below it, a ſquare platform, ſuch as we have deſcribed at the weſt end of the fortification on Craig-Phadrick. The tradition is, that this platform at Crown-bridge, was the *arena* where two competitors decided, in ſingle combat, the diſputed right to the Crown of Ireland. WRIGHT, in his *Lowthiana*, or introduction to the antiquities of Ireland, deſcribes and gives plans of many ſuch fortified mounts, all of which are ſurrounded by ramparts; and moſt of them have at the extremities ſtrong outworks below the level of the fort itſelf. One of theſe, which is called *Green Mount*, near Caſtle-Bellingham, appears from the engraving in Mr WRIGHT's book, to bear a near reſemblance in its plan to Craig-Phadrick.

NONE of thoſe remains of building upon the hills in Ireland, ſo far as is taken notice of in the deſcriptions of them I have mentioned, exhibit any marks of vitrification. Three of the fortifications I have enumerated in the neighbourhood of Inverneſs, are likewiſe crowned with dry ſtone ſtructures, without any appearance of the effects of fire; and I am inclined to believe, that, upon an accurate ſurvey of thoſe extraordinary

 works,

works, the number of thofe that fhow marks of vitrification will be inconfiderable, when compared with thofe that have not been at all affected by fire. I am led, from this circumftance, to form an opinion different from that of Mr WILLIAMS, and of fuch as believe thofe ftructures to be the proofs of an ancient mode of building, in which fire was employed for the purpofe of cementing, before our anceftors knew the ufe of lime. I am difpofed to think, that the appearances of vitrification on fome of thofe hills, are the accidental effects of fire upon a ftructure compofed of combuftible and fufible materials, and by no means the confequence of an operation intended to produce that effect.

THE buildings reared by the ancient inhabitants of this country, both for habitation and defence, would naturally be compofed of fuch materials as the rude ftate of the country prefented in abundance, and fuch as required little, either of labour or of fkill, to bring into ufe. In thofe quarters where ftone could be eafily quarried in fquare blocks, or where it fplit into *laminæ*, no other material than the fimple ftone was neceffary, and very little labour was fufficient to rear the ftructure. Such has been the cafe at Dun-Jardel and Dun-Evan. But where the ftone is of that nature as not to be eafily fplit into fquare blocks, or feparated into *laminæ*, but is apt to break into irregular and generally fmall fragments, as the rock of Craig-Phadrick, and all others of the plum-pudding kind, it would be extremely difficult to form a regular ftructure of fuch materials alone, which fhould be endowed with fufficient ftrength. The mode in which I imagine building was practifed in fuch fituations, was by employing wood, as well as ftone, in the fabric. The building, I fuppofe, was begun by raifing a double row of pallifades or ftrong ftakes, in the form of the intended ftructure, in the fame way as in that ancient mode of building, defcribed by PALLADIO under the name of *Riempiuta*,

a caſſa, or coffer-work *. Theſe ſtakes were probably warped acroſs by boughs of trees laid very cloſely together, ſo as to form two fences, running parallel to each other at the diſtance of ſome feet, and ſo cloſe as to confine all the materials, of whatever ſize, that were thrown in between them. Into this intermediate ſpace, I ſuppoſe, were thrown boughs and trunks of trees, earth and ſtones of all ſizes, large or ſmall, as they could quarry or collect them. Very little care would be neceſſary in the diſpoſition of theſe materials, as the outward fence would keep the mound in form. In this way, it is eaſy to conceive, that a very ſtrong bulwark might be reared with great diſpatch, which, joined to the natural advantage of a very inacceſſible ſituation, and that improved by artful contrivances for encreaſing the difficulty of acceſs, would form a ſtructure capable of anſwering every purpoſe of ſecurity or defence.

The moſt formidable engine of attack againſt a ſtructure of this kind, would be fire; and this, no doubt, would be always attempted, and often ſucceſsfully employed by a beſieging enemy. The double ramparts, at a conſiderable diſtance from each other, and the platform, at one end, were certainly the beſt poſſible ſecurity againſt an attack of this kind. But if the beſiegers prevailed in gaining an approach to the ramparts, and, ſurrounding the external wall, ſet fire to it in ſeveral places, the conflagration muſt ſpeedily have become general, and the effect is eaſy to be conceived. If there happened to be any wind at the time, to increaſe the intenſity of the heat, the ſtony parts could not fail to come into fuſion,

 and

* La maniera *riempiuta* che ſi dice anco *a caſſa*, facevano gli antichi, con tavole poſte in coltello tanto ſpacio, quanto volevano che foſſe groſſo il muro, empiendolo di malta, e di pietre di qualunque ſorte meſcolate inſieme, e coſi andavano facendo di corſo in corſo. Si veggone muri di queſta ſorte a Sirmion ſopra il lago di Garda. Di queſta maniera ſi poſſono anco dire le mura di Napoli, cioe le antiche, le quali hanno due muri di ſaſſo quadrato, groſſi quattro piedi, e diſtanti tra ſe piedi ſei — e ſono empiute di ſaſſi e di terra. Pallad. *Architect. lib.* 1. *cap.* 9.

and (as the wood burnt away) ſinking by their own weight into a ſolid maſs, there would remain a wreck of vitrified matter, tracking the ſpot where the ancient rampart had ſtood; irregular and of unequal height, from the fortuitous and unequal diſtribution of the ſtony materials of which it had been compoſed. The appearance at this day of thoſe vitrified mounds creates the ſtrongeſt probability of the truth of this conjecture. They do not appear ever to have been much higher than they are at preſent; as the fragments that have fallen from them, even in thoſe places where the wall is loweſt, are very inconſiderable. From the durable nature of the ſubſtance, they muſt have ſuffered very little change from time, though, from the gradual growth of the ſoil, they muſt, in ſome places, have loſt, in appearance, a good deal of their height, and, in others, have been quite obſcured. Mr WILLIAMS, in making a cut through the ramparts at Knockfarril, found, in many places, the vitrified matter entirely covered with peat-moſs of half a foot in thickneſs.

I HAVE obſerved, that, in the fortification on Craig-Phadrick, a large portion of the outward rampart upon the north ſide bears no marks of vitrification. The reaſon of this it is eaſy to explain. In the ſtructure of this part of the wall no wood has been employed; for the extreme ſteepneſs of the rock on this quarter rendered any rampart for defence entirely unneceſſary. A low fence of ſtones and turf was ſufficient here to prevent the cattle, which were probably lodged between the outer and inner rampart, from falling over the precipice. Such is that fence which at preſent remains on the north ſide of the rock of Craig-Phadrick.

IT appears, therefore, highly probable, that the effect of fire upon thoſe hill-fortifications, has been entirely accidental, or, to ſpeak more properly, that fire has been employed, not in the conſtruction, but towards the demolition of ſuch buildings; and for the latter purpoſe it would certainly prove much more

efficacious

efficacious than for the former. It is much to be doubted, whether it would be at all poſſible, even in the preſent day, by the utmoſt combination of labour and of ſkill, to ſurround a large ſpace of ground with a double rampart of ſtones, compacted by fire, of ſuch height and ſolidity as to ſerve any purpoſe of ſecurity, or defence againſt a beſieging enemy. Any ſtructure of this kind muſt have been irregular, low, fragile, eaſily ſcaled and quite inſecure; a much weaker rampart, in ſhort, than a ſimple wall of turf or wooden palliſade. The veſtiges yet remaining, as I have already obſerved, give no room to ſuppoſe, that the vitrified mound has ever been much more entire than it is at preſent. The effect of fire upon ſtructures reared in the manner I have ſuppoſed them to have been, will account moſt perfectly for their preſent appearance.

It was from neceſſity that the builders of thoſe fortifications betook themſelves to a mode of ſtructure ſo liable to be deſtroyed by fire. In thoſe parts where ſtones could be eaſily quarried, of ſuch ſize and form as to rear a rampart by themſelves of ſufficient ſtrength and ſolidity, there was no occaſion to employ wood or turf in its conſtructon, and it was therefore proof againſt all aſſault by fire. Such are the ramparts which appear on the hill of Dun-Jardel, Dun-Evan, and many others, on which there is not the ſmalleſt appearance of vitrification. But on Craig-Phadrick, and the other hills above deſcribed, where, from the nature of the rock, the ſtones could be procured, only in irregular and generally ſmall fragments, it was neceſſary to employ ſome ſuch mode of conſtruction as I have ſuppoſed; and theſe ramparts, though ſolid and well calculated for defence againſt every attack by force or ſtratagem, were not proof againſt the aſſault by fire.

But thoſe ancient fortifications preſent a much more curious and more intereſting object of ſpeculation, than thoſe uncertain and indeed fruitleſs conjectures as to the mode in which they have been reared. It is evident, that, were it poſſible to

aſcertain

ascertain the æra in which those fortifications were constructed, some useful light might be thrown upon the ancient history of this country, and the condition of society in those remote periods. This I shall now attempt; and, in the course of a short disquisition upon that subject, shall have occasion to mark the progress of architecture in Britain, from its first introduction into the southern parts, till it had attained to considerable perfection, and the knowledge of the art of building had extended itself, in some degree, to the remotest quarters of the island.

At the time when those fortifications were reared, it is evident that the use of mortar was unknown. As it must be supposed that the builders exerted the utmost of their architectural skill (so far as strength was concerned) in fabricating those structures, we cannot doubt, that, as the country abounded in lime-stone, had its use been known as a cement, it must have been employed in such works. This brings them at once up to a period of time prior to the Roman establishments in the northern parts of Britain. The Romans employed mortar in all their buildings, of which many remains are at present existing in those parts of the island where they are known to have formed settlements. They taught the Britons the use of that cement, of which, till then, they were ignorant.

At the time of Cæsar's invasion of Britain, the inhabitants of the southern, and probably the most civilized part of the island, lived in huts constructed with turf, or with the branches of trees. Their towns or villages were nothing more than an inclosed part of a wood, surrounded by a ditch and rampart, within the circle of which they reared their huts. "Oppidum vocant Britanni cum sylvas impeditas vallo atque fossa munierunt." Cæs. *de Bell. Gal. lib.* 5. *cap.* 21. These inclosures or towns were but a temporary residence, and probably resorted to, only when it was necessary to defend

themselves

themſelves againſt an enemy *. They were ſo ſpacious as to afford ſecurity, both to the inhabitants themſelves and to their cattle. " Urbium loco ipſis ſunt nemora. Arboribus enim " dejectis ubi amplum circulum ſepierunt, ibi caſas ibidem ſibi " ponunt, et pecori ſtabula condunt, ad uſum quidem non " longi temporis." STRABO *Geogr. lib.* 4. †. Of this nature were all the Britiſh towns in the ſouthern part of the iſland at the time of CÆSAR. Such was the town of Caſſibelanus, probably a place of the greateſt conſideration in the iſland, as being the reſidence of that chief under whom the whole of the ſouthern Britons agreed to unite their forces to oppoſe the Romans at their ſecond deſcent upon the coaſts. " Ab his cog- " noſcit non longe ex loco oppidum Caſſibelani abeſſe, ſilvis pa- " ludibuſque munitum, quo ſatis magnus hominum pecoriſ- " que numerus convenerit." CÆS. *de Bello Gal. lib.* 5. *cap.* 21. This oppidum Caſſibelani was Verulamium, the preſent St Albans. (See CAMDEN, and HORSLEY's *Britannia Romana.*) London, or the capital of the Trinobantes, was then a place of inferior note to Verulam. The Romans dignified the latter with the title of a *municipium*, while the former was ſimply an *oppidum*; and therefore ſtrictly correſpondent to CÆSAR's general deſcription; a portion of a thick wood ſurrounded with a ditch and rampart.

IF

* THE picture given by TACITUS of the manner of life of the Germanic tribes, may probably be applied, with very little difference, to all the contemporary barbarous nations of Europe: " Nullas Germanorum populis urbes habitari ſatis notum eſt, ne pati " quidem inter ſe junctas ſedes. Colunt diſcreti ac diverſi, ut fons, ut campus, ut ne- " mus placuit. Vicos locant non in noſtrum morem, connexis et cohærentibus ædificiis: " ſuam quiſque domum ſpatio circumdat, ſive adverſus caſus ignis remedium, ſive in- " ſcitia ædificandi. Ne cæmentorum quidem apud illos, aut tegulorum uſus." TACIT. *de Mor. Germ. cap.* 16.

† Πολεις δε αυτων εισιν οι δρυμοι. περιφραξαντες γαρ δενδρεσι καταβεβλημενοις ευρυχωρη κυκλον, και αυτοι ενταυθα καλυβοποιουνται, και τα βοσκηματα καταςαθμευουσιν, ου προς πολυν χρονον. STRABO Geog. l. 4.

If ſuch was the appearance of London at the time of the ſecond invaſion of the iſland by Cæsar, which happened fifty-five years before the Chriſtian æra, we have certain evidence, that the ſouthern Britons had undergone a remarkable change in their mode of life, and made a great progreſs in refinement and civilization in the ſpace of 107 years, which elapſed from that time to the great victory gained over the Romans by their Queen Boadicea. At this latter period, Tacitus mentions London as a flouriſhing town, which, though not dignified with the title of a Roman colony, was a place of trade and opulence, and a great reſort for merchants. "Londinum quidem cognomento coloniæ non inſigne, ſed copia negotiatorum et commeatuum maxime celebre." *Annal. lib.* 14. *cap.* 33. The Britons of the ſouth had, therefore, profited very greatly by a ſhort intercourſe with the Romans; and this progreſs will appear more remarkable when it is conſidered, that, from the time of Cæsar's invaſion to the reign of Claudius, during almoſt a complete century, there was no Roman army in Britain, nor any ſtation or ſettlement of that people in the iſland*. The Britons, therefore, had, as yet, enjoyed little more than the ſight of a poliſhed and improved people. Amidſt the tumult of hoſtilities, there was no opportunity to imitate the practices or ſtudy the accompliſhments of the people by whom they were invaded; but they ſaw enough to convince them of their own ſignal inferiority in all the arts of cultivated life, and to excite a deſire to imitate them in a ſubſequent ſeaſon of tranquility. This they obtained by the retreat of the Romans; and profiting to the utmoſt by thoſe lights they had acquired, they made a more rapid advancement to civilization, than perhaps in any after period of their hiſtory. Cities were built, harbours conſtructed

* Horseley's Britannia Romana, p. 19, 20.; and Tacitus mentions both the fact and its cauſe. "Mox bella civilia et in rempublicam verſa principum arma ac longa oblivio Britanniæ etiam in pace." *Vit.* Agric. *cap.* 13.

ſtructed for the accommodation of mercantile fleets *, and money coined for the medium of trade. The coinage of CUNOBELINE, the ſucceſſor of CASSIBELANUS, and Sovereign of the Caſſii and Trinobantes, from the mints of Colcheſter, Verulam and London, is a proof, not only of an extenſive commerce, but of very conſiderable advancement in the arts †.

IN this interval, therefore, between the invaſion of CÆSAR and the reign of CLAUDIUS, this period of rapid improvement, it is probable the Britons of the ſouth firſt learned the art of conſtructing durable buildings with mortar; though we do not find from any claſſic author, that, before the reign of NERO, the Romans had erected any buildings in the iſland which could ſerve as a model of regular architecture. In the fifth year of the Emperor NERO happened that ſignal defeat of the Romans by the Britiſh Queen BOADICEA, occaſioned principally by the revolt, or, as TACITUS terms it, the rebellion of the Trinobantes. One great cauſe of this revolt had been the erection of a magnificent *Temple* to the divine CLAUDIUS, which the Britons regarded as an inſulting monument of the Roman power and their own abject ſlavery. "Ad hæc templum divo CLAUDIO conſtitutum, quaſi arx æternæ dominationis aſpiciebatur; delectique ſacerdotes, ſpecie religionis, omnes fortunas effundebant." TACIT. *Annal. lib.* 14. *cap.* 31. That this temple was a ſtructure of great magnitude and ſolidity, appears from this circumſtance, that the Romans retreated to it as their laſt ſtrong hold, and, for two days, defended themſelves in it againſt the beſieging Britons. "Cætera quidem impetu direpta aut incenſa ſunt: Templum in quo mi-

* SEE an accurate account of the commencement of the commerce of Britain in WHITAKER's Hiſtory of Mancheſter, book I. chap. 11.

† ABOUT fifty coins of CUNOBELINE have come down to the preſent times. They are of gold, of ſilver and of braſs; and ſome of them are elegant in their fabric and device.

" les ſe conglobaverat, biduo obſeſſum expugnatumque." *Ibid. cap.* 32.

THE Britons, proſecuting their ſucceſs, attacked, pillaged and ſet fire to ſeveral of the Roman forts and garriſons. London and Verulam were deſtroyed; and, in theſe two places, (a convincing proof of their magnitude and population) the Britons maſſacred about 70,000 Roman citizens and their allies *. But theſe temporary ſucceſſes were ſoon checked by a dreadful defeat of the Britons by SUETONIUS PAULINUS, in which 80,000 were left dead upon the field of battle. From that time, the Romans advanced into the internal parts of the iſland; and, finding themſelves more feebly reſiſted, as their power became more known, began now to apply themſelves to the civilization of the rude people whom they had ſubdued. JULIUS AGRICOLA, in the ſecond year of his command, as Propraætor of Britain, A. D. 79. reduced the inhabitants of North Wales, of Cheſhire and of Lancaſhire, to abſolute ſubjection, and conquered the iſle of Angleſey. Having ſufficiently evinced his power, he tried the effect of alluring the natives to an eaſy ſubmiſſion, by giving them a taſte of the enjoyments of a poliſhed people †. Towards this purpoſe, the Romans encouraged the Britons to build regular towns, aſſiſted them in conſtructing temples, market-places and commodious dwellings, and taught them even the uſe of the baths and porticos, and all the luxuries of the Roman banquets ‡. To this preciſe

* AD ſeptuaginta millia civium et ſociorum iis quæ memoravi locis, cecidiſſe conſtitit. TACIT. *Annal. lib.* 14. *cap.* 33.

† UBI ſatis terruerat parcendo rurſus irritamenta pacis oſtentare. JUL. AGRIC. *Vit. cap.* 20.

‡ SEQUENS hiems ſaluberrimis conſiliis abſumpta. Namque ut homines diſperſi ac rudes, eoque bello faciles, quieti et otio per voluptates aſſueſcerent, hortari privatim, adjuvare publice, ut templa, fora, domos extruerent, laudando promptos, aut caſtigando ſegnes—paullatimque diſceſſum ad delinimenta vitiorum, porticus et balnea et conviviorum elegantiam. JUL. AGRIC. *Vit. cap.* 21.

precise period, we may refer the foundation of many of the towns in the west of England, which are known to have had a Roman origin, as Lancaster, Manchester, Warrington, Ribchester, Overborough, Colne, *&c.* *.

At this time, therefore, A. D. 79, the Britons of the north-western parts of England, had acquired a considerable knowledge of regular architecture. But all to the north of the Roman conquests, we must presume was in its original state of barbarism. Improvement, however, must have kept pace with the advances of the Romans into the country; and it is therefore not difficult to mark its progress. In the year 80, we find Agricola employed in erecting a chain of forts between the friths of Clyde and Forth; and in 83 †, the last year of his command, he had penetrated to the foot of the Grampian mountains in the northern parts of Angus. From this time, during the remainder of the reign of Domitian, and through the whole of the reigns of Nerva and of Trajan, a period of above thirty years, the Romans made no progress in the island. The northern parts of the province were ill defended, and the Caledonians, in that interval, recovered all that part of Scotland which Agricola had gained; for, in the second year of Hadrian, A. D. 120, when that Emperor built his *vallum* across the island, between Solway frith and the mouth of the Tyne, he considered the Roman Province as extending no further to the north than that rampart. " Murum per octoginta " millia passuum primus duxit qui barbaros Romanosque divi- " deret." *Vit. Hadr. Hist. Aug. Script.*

This interval, therefore, of more than thirty years, must have been a period of remarkable improvement to the savage Caledonians. Maintaining a constant intercourse with the Romans, not distinguished by extraordinary hostilities, and gradu-

 ally

* Whitaker's Manchester, book I. chap. 7.

† Or 84; for the year is not certain. See Horsley, p. 48.

ally regaining a country in which they found the recent works of a poliſhed people, they could not fail to acquire much knowledge in the arts. At the time, therefore, when ADRIAN built his rampart, A. D. 120, we know, almoſt to a certainty, that the inhabitants of Scotland, as far to the north as the Grampian mountains, underſtood and practiſed the art of conſtructing durable buildings with mortar. The forts or *caſtella* erected by AGRICOLA, which TACITUS * ſays were ſo ſtrongly conſtructed as to reſiſt the utmoſt efforts of the enemy to take them by ſtorm, were now in the poſſeſſion of the Caledonians. The Roman caſtella were circular, and ſometimes ſquare, incloſures, ſurrounded with a ſtrong wall of ſtone, hewn into ſquare blocks, and cemented with mortar. The ſpace incloſed was ſufficient to contain various buildings likewiſe of ſtone, barracks for the winter habitation of the troops, granaries for proviſions, and ſometimes baths. The form of theſe caſtella may be ſeen in the ſculptures upon the Trajan column, and their conſtruction may be learnt from VEGETIUS. The remains of a bath belonging to one of theſe caſtella, probably erected by AGRICOLA, were diſcovered, within theſe few years, at the village of Dalnoter, between Glaſgow and Dumbarton. The Caledonians had witneſſed the building of thoſe ſtructures, which were reared with the moſt perfect ſkill in military architecture, from materials which the country furniſhed in abundance. They were now in poſſeſſion of the ſtructures themſelves. It is reaſonable, therefore, to conclude, that they now learnt the art of conſtructing regular buildings with ſtone and mortar, and practiſed it, both for the purpoſes of defence and habitation; becauſe the contrary ſuppoſition would do violence to all probability.

THE wall of ADRIAN, which was built in 120, and that of ANTONINUS PIUS, built, as HORSLEY thinks, in 140, were both

* Vit. AGRIC. cap. 22.

both conſtructed ſolely of turf *. But they were defended by caſtella, placed at intervals of various diſtance, according to the nature of the ground. The wall of ANTONINUS ran acroſs from Dumbarton on Clyde to Cramond on the frith of Forth, and was probably in the preciſe line of the caſtella built by AGRICOLA. It was at this period, and under the command of LOLLIUS URBICUS, the lieutenant of ANTONINUS, that the Romans made their fartheſt advances into the iſland of Britain. After the erection of this new vallum, which had probably been reared in the idea, that the country to the north of it was hardly worth ſecuring, URBICUS marched to the northward, and finding, beyond his expectation, that the country, eſpecially along the ſea-coaſt, was open and fertile, he appears to have proſecuted his conqueſts as far north as Inverneſs. For this fact, we want indeed the authority of any Roman hiſtorian; but the Geography of PTOLEMY, and the late diſcovered itinerary of RICHARD of Cirenceſter, prove, beyond all doubt, that there were Roman ſtations in the neighbourhood of Inverneſs; and there is no other Roman general, but URBICUS, who, to the days of PTOLEMY, can be ſuppoſed to have paſſed the limits of AGRICOLA's conqueſts †. The moſt northerly Roman ſtation, according to PTOLEMY, is the πτερωτον ϛρατοπεδον, or caſtra alata, which, in the itinerary of RICHARD, is termed Ptorotone. This, I think, there is every reaſon to believe to have been that fortified promontory, now called the Burgh of Moray ‡. At any

* JULIUS CAPITOLINUS, in his life of ANTONINUS PIUS, mentions, that this Emperor excluded the barbarians from the Province, " *alio* muro ceſpitio," which proves that the former, *viz.* that of ADRIAN, was of the ſame materials.

† WHITAKER's Hiſtory of Mancheſter, book I. chap. 3. § 1.

‡ ITS ſhape correſponds entirely to the name of an encampment with wings. Such is the actual form of the promontory; and although both STUKELEY and HORSLEY place the ſtation of Ptorotone at Inverneſs itſelf, it will be obſerved, this is nothing more than conjecture. The itinerary of RICHARD gives no authority for that preciſe ſituation; for

any rate, it is certain there were ſeveral Roman ſtations in that neighbourhood, as Tueſſis, Varis and Ptorotone, which is ſufficient for our purpoſe. It is then evident, that, in the reign of ANTONINUS PIUS, and within a few years of A. D. 140, the date of his *vallum*, the Romans had fixed præſidia and built caſtella in the neighbourhood of Inverneſs, from which part of Scotland, there was an uninterrupted military road, as appears by RICHARD's itinerary, to the Land's end in Cornwall. At this period, therefore, the inhabitants of this region of Scotland muſt have been acquainted, from the practice of the Romans, with the art of building with mortar. And, as the ſtructure of thoſe hill-fortifications demonſtrates the ignorance of the builders of the uſe of that cement, the moſt complete evidence thence ariſes, that they were reared prior to the time above mentioned, that is, above ſixteen centuries and a half ago.

BUT how far beyond that period we are to ſearch for the date of thoſe ſingular fortifications, ſtill remains in doubt. All that we can, with certainty, conclude, is, that they belong to a period of extreme barbariſm. They muſt have been conſtructed by a people ſcarcely removed from the ſtate of ſavages, who lived under no impreſſion of fixed or regulated property in land, whoſe only appropriated goods were their cattle, and whoſe ſole ſecurity, in a life of conſtant depredation, was the retreat to the ſummits of thoſe hills of difficult acceſs, which they had fortified in the beſt manner they could. As the ſpace incloſed was incapable of containing a great number of men, eſpecially if occupied in part by cattle, it is preſumable, that theſe retreats were formed chiefly for the ſecurity of the women

for the diſtance in miles between Ptorotone, and the preceding ſtation Tueſſis, is left blank in the itinerary, and the actual ſituation of Tueſſis is likewiſe uncertain, HORSLEY fixing it at Nairn, and STUKELEY at Ruthven on the Spey. All that is certainly known from RICHARD's itinerary, is, that Ptorotone was the third Roman ſtation beyond the Grampian mountains.——Since writing the above, it was a ſatisfaction to me to find, that General ROY, in his elegant map of Roman North Britain, has actually placed Ptoroton, or Ptorotone, at the burgh-head of Moray.

men and children of the canton, and of their herds. They could be defended by a few men, while the reſt of the tribe were engaged with their enemies in the field.

In the deſcription I have given of the fortified hill of Dun-Jardel upon Loch-Neſs, I mentioned a Druidical circle upon the ſhoulder of the hill about fifty or ſixty feet below the fortification; and hinted, that this circumſtance might poſſibly afford ground for a conjecture with regard to the date of thoſe extraordinary ſtructures on the tops of hills.

The religion of the Druids obtained in Britain long before the period of the Roman invaſion; and it was probably introduced into the iſland by the firſt colony of Celtæ or Gauls who landed from the continent *. If, as is generally ſuppoſed, this iſland was actually peopled from Gaul, Druidiſm muſt have been the religion of its firſt inhabitants. I am diſpoſed, however, to believe, that this iſland was inhabited of old by a race of men who knew nothing of the religion of the Druids, whoſe manners and mode of life were too barbarous to be compatible with that ſyſtem, and who, in after times, adopted from thoſe Druids their firſt ideas of civilization and improvement. The Druids, it is well known, were a very enlightened order of men; and they had the addreſs to avail themſelves of that character of wiſdom and learning, in obtaining an abſolute controul, not only in matters of religion, but in the civil government of the countries in which they were eſtabliſhed. They cultivated the mechanic arts, and even the ſciences of Medicine, Aſtronomy and Geometry, with conſiderable ſucceſs. In ſhort, no nation, among whom that ſyſtem had become prevalent, could long remain in a ſtate of barbariſm. But, from all the ideas we can form

* This idea is not contradicted by the fact, of which we are aſſured by Cæsar, *viz.* That the Druids of Gaul were ſent over for inſtruction to Britain. This fact proves only, that the Britiſh Druids, in the ſolitude of the diſtant iſland of Mona, had made farther advances in the ſciences at that time, than their brethren on the continent. Cæsar indeed thence conjectures, that the Druidical ſyſtem had been invented in Britain; but this conjecture has no other baſis than the fact above mentioned.

form of the ſtate of Caledonia, at the time when it was neceſſary to rear thoſe hill-fortifications, there appears no probability that the inhabitants either lived under ſuch a government as we know to have prevailed under the influence of the Druids, or had any acquaintance with thoſe arts which it is certain they cultivated. Thoſe buildings muſt, therefore, have been erected previouſly to the introduction of the Druidical ſyſtem; that is to ſay, in a period of time antecedent to the firſt viſitation of this iſland by the Celtæ of Gaul.

THE Druidical circle upon Dun-Jardel lends its aid in ſupport of this conjecture. If the fortification on the ſummit had been erected after the abolition of Druidiſm, it ſeems extremely improbable, that the builders of it would have neglected to employ the ſtones of this circle in rearing their fortification, (ſtones extremely well ſuited to the purpoſe, and quite at hand) when they have been at immenſe pains to carry up a prodigious quantity of ſtones from the very bottom of the hill for that work. It is not probable that they would have been reſtrained by any ſuperſtitious idea of reverence for the monuments of an extinguiſhed religion. For Druidiſm, ſoon after its abolition, ſunk into utter contempt, and the introduction of Chriſtianity rendered the ancient ſuperſtitions impious and deteſtable. That this hill-fortification was erected in the times of the Druids, I have already ſhewn to be extremely improbable. We muſt, therefore, recur to the only remaining, and the moſt natural ſuppoſition, that it was reared in times antecedent to the introduction of that religion. And this ſuppoſition carries the date of this ſtructure, and conſequently of all the reſt of the ſame nature, up to a period of antiquity far beyond all hiſtorical record, and connects them with a ſtate of ſociety in which the arts were as imperfect, the manners as barbarous, and the condition of life as lawleſs, turbulent and precarious, as among the rudeſt tribes of American ſavages.

II.

Plate I.

Fig. 1

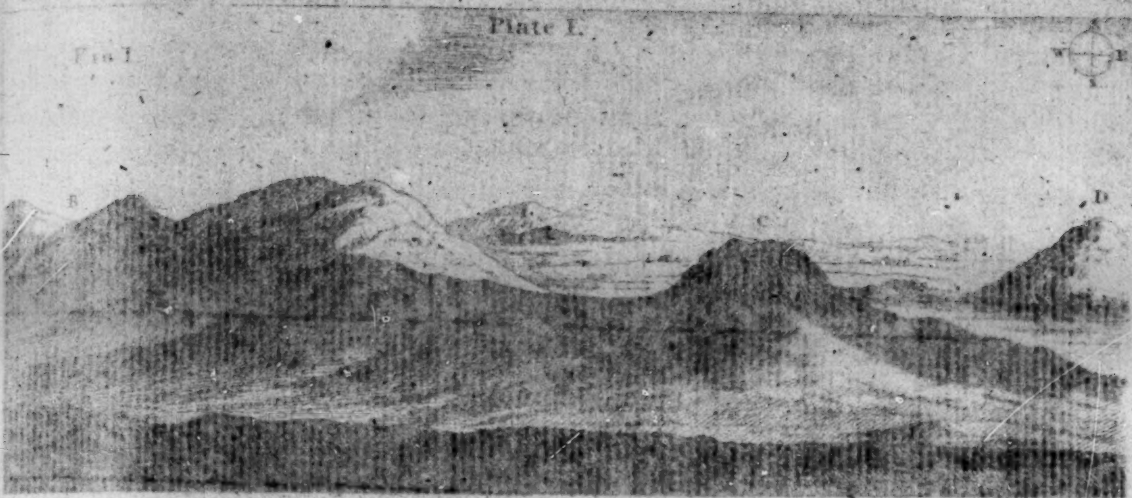

Fig. 2

CRAIG-PHADRICK.

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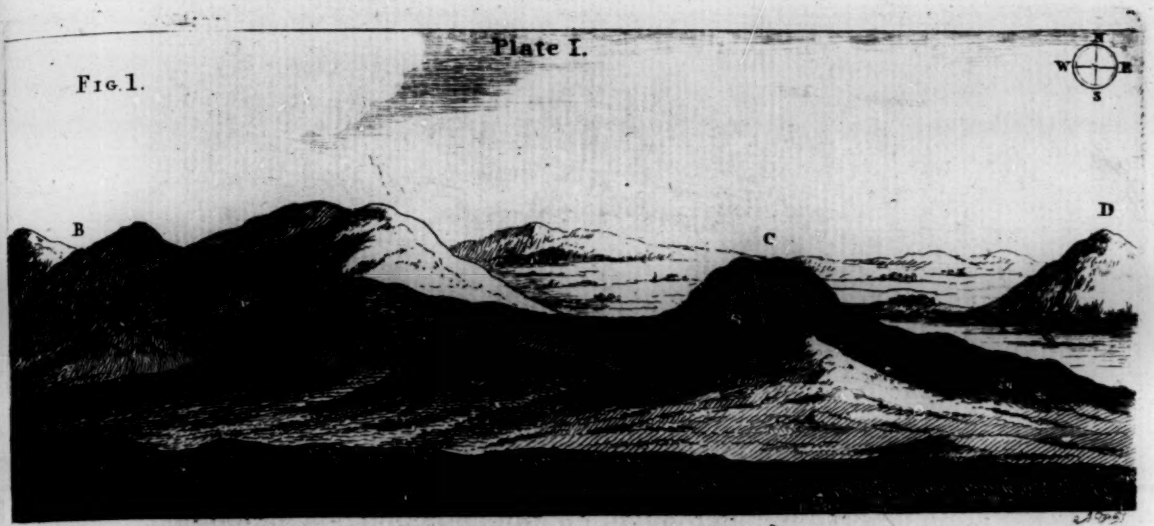


Fig. 2.

Plate II

Fig. 1.

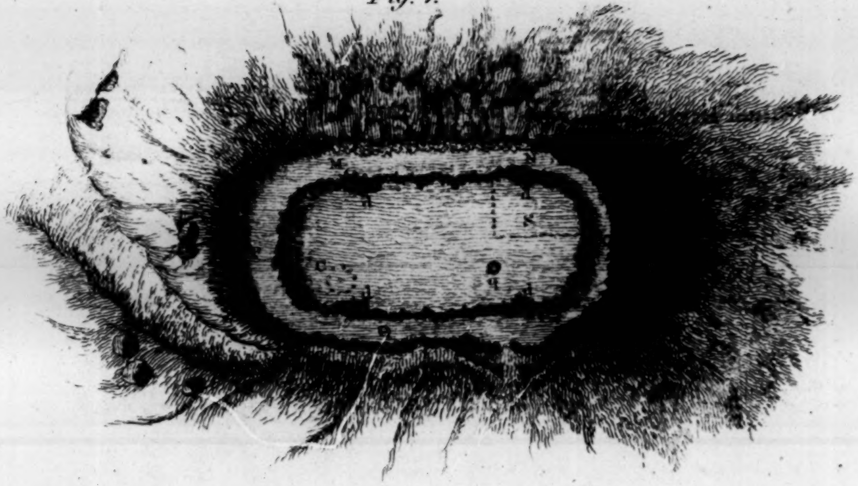
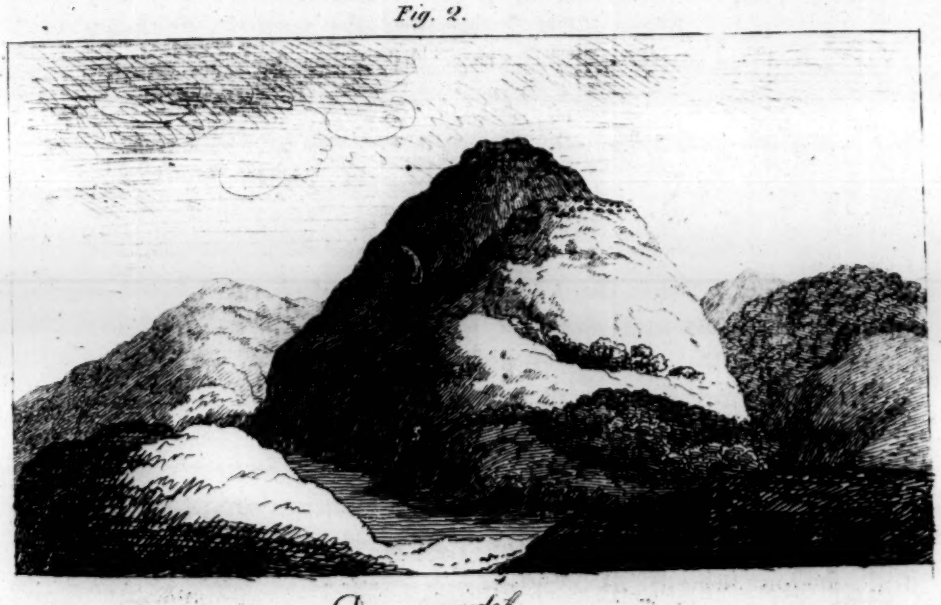


Fig. 2.



Dun-jardel

II. REMARKS *on some Passages of the sixth Book of the* ENEID. *By* JAMES BEATTIE, LL. D. F. R. S. EDIN. *and Professor of Logic and Moral Philosophy in the Marischal College, Aberdeen.*

[*Read by Mr* DALZEL, *Secretary*, *March* 19. 1787.]

THE poetical beauties of VIRGIL's sixth book are great and many; and a most agreeable task it would be to point them out: but that is not my present purpose. Nor do I intend to draw a comparison of the sentiments of our poet with those of HOMER, concerning a future state. From HOMER, no doubt, VIRGIL received the first hint of this episode; but the evocation of the ghosts, in the eleventh book of the Odyssey, is not in any degree so striking, or so poetical, as ENEAS's descent into the world of spirits. Nor does the former exhibit any distinct idea of retribution. In it all is dark and uncomfortable. "I would rather, says the ghost of "ACHILLES, be the slave of a poor peasant among the living, "than reign sole monarch of the dead:" a passage blamed, not without reason, by PLATO, as unfriendly to virtue, and tending to debase the soul by an unmanly fear of death.

MY design is, to give as plain an account as I can of the *theology* (if I may be allowed to call it so) of this part of VIRGIL's poem. And I shall make the poet his own interpreter, without trusting to commentators, or seeking unnecessary illustrations from PLATO, to whom VIRGIL, though he differs from him in many particulars, was indebted for the outlines of

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the system, and who probably owed them to philosophers of the Pythagorean school.

THE learned Bishop WARBURTON has commented on this part of the Eneid. Many of his observations are pertinent, but some are fanciful; and in more places than one he seems to have misunderstood the author. His general position is, That what the poet says of Elysium and the infernal regions, we are to understand as nothing more than a figurative account of the mysteries exhibited in the temple of CERES at Eleusis; and that the poet meant in this way to tell us, that ENEAS had, like some other heroes and lawgivers of old, been initiated into those mysteries. This theory he supports very ingeniously, but not, I believe, to the satisfaction of many readers. I admit there are allegories in the book, as I shall have occasion to show; but that the whole is an allegory, or rather an allegorical representation of the Eleusinian allegories, I can no more suppose, than that the arrival at Carthage is an allegory, or the visit to EVANDER, or the combat with TURNUS, or any other of our hero's achievements. I consider this episode as truly epic, and as a part, though not a necessary part, of the poet's fable; and that he contrived it, first, that he might embellish his work with a poetical account of a future state, and secondly, and chiefly, that he might thence take an opportunity to introduce a compliment to his country, by celebrating the virtues of some of the great men it had produced. As these great men did not flourish till after the death of ENEAS, there were but two ways in which the poet could make him acquainted with them. One was, by causing some priest or soothsayer to prophecy concerning them; and the other, by so availing himself of the doctrines of pre-existence and transmigration, then taught in some of the schools, as to exhibit in their pre-existent state, such of the hero's posterity as there might be occasion for. He chose the latter method; and has so managed it, that we must acknowledge the choice to have been judicious.

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As the chief thing I have in view is, to illustrate the moral and theological sentiments of my author, I need not take up much time, either in vindicating, or in apologizing for, his general fiction; I mean, his laying the scenery of a future state in the subterranean regions. That on the coast of Italy, in the neighbourhood of Cumæ, there should be a passage under ground, leading to the rivers Acheron, Cocytus and Styx, and thence to Tartarus on the left hand, and Elysium on the right; that in this Elysium, though thus situated, there should be a sun and stars, and grassy plains, and delightful groves and rivers, and two gates, the one of ivory, the other of horn, opening into the upper world, at no great distance from the Cumæ above mentioned; and that in the subterranean spaces thus bounded, there should be different sorts of accommodation for all the shades or souls of the dead:—these, I say, are fables, which, as they cannot, according to our way of judging, be reconciled to probability, or even to possibility, we must endeavour to acquiesce in the best way we can. So, in reading OVID's story of Phaeton, if we would enter into the poet's views, and be suitably affected with his narrative, we must suppose, what we know to be absolutely impossible, that the sun is driven about the world in a chariot, which, though made of gold and silver, and dragged by real horses, and supported by nothing but air, yet passes along in a beaten highway, where the marks of the wheels are clearly discernible. Fables of this sort, however inconsistent with the laws of nature, when rendered by the art of the poet consistent with themselves, it is not our interest to criticize too minutely; especially if, like that now under consideration, they abound in sublime description and instructive lessons of morality. The fable then let us acquiesce in for a moment. Our dreams, while they last, we believe without inconvenience; and the scenery of this fable will not be more lasting than that of a dream.

As a sort of apology for the wildness of some parts of this fable, it may be remarked, that formerly at Cumæ, near which the Trojan fleet was now stationed, there lived a prophetess called the Cumean Sybil; that in her neighbourhood, encompassed with thick woods, there was a lake called Avernus, which emitted pestilential steams; that in the same parts of Italy there are many dreadful caverns, one of which is to this day called the Sybil's Grotto; and that for those who knew nothing of the real size of the earth, or the final destination of man, it was not altogether absurd to imagine, as all dead bodies return to the earth, that the subterranean regions might be the mansions of the ghosts or shades of human beings departed.

The necessary sacrifices being performed, and Eneas having found in the woods that golden bough which, being intended as a present to Proserpine, was to serve him as a passport through her dominions; the Sybil or priestess plunged into the cavern, calling to him to follow her, with his sword drawn in his hand. They went a great way through a lonely region, where there was no more light than one travelling in a wood receives in a cloudy night from the moon. At length they arrived at the entrance of the infernal world, where a number of terrible beings resided; Disease, Old Age, Fear, Famine, Poverty, and Death, and Labour, and War, and Discord; and such monstrous things as centaurs, gorgons, harpies and giants, one with three heads, and another with a hundred hands, and the chimera breathing fire, and the many-headed serpent of Lerna roaring hideously. By placing these at the entrance, the poet perhaps intended to signify, in the way of allegory, the horrors that accompany the near approach of death; or perhaps those many evils, real and imaginary, which we must all pass through in our way to the other world.

From this place to the river Styx was a region, in which the ghosts of those, whose bodies had not been honoured with the rites

rites of fepulture, were obliged to wander in a melancholy condition for the fpace of an hundred years, before they could be permitted to pafs the river, or appear before any of the infernal judges. Here ENEAS met with his old pilot PALINURUS, who, in their laft voyage, having fallen overboard in the night, and fwam to the main land of Italy, was there murdered by the natives, who did not give themfelves the trouble to bury him, but threw his body into the fea. He begged ENEAS to take him under his protection, and procure him a paffage over the Styx. " It cannot be, faid the Sybil; you muft have pa-
" tience. In the place where you were murdered, there will
" foon be prodigies, which will induce the natives to perform
" your funeral rites, and call a promontory after your name;
" and then you may pafs the river, but not before." PALINURUS acquiefced; well pleafed to hear that fuch honours awaited him.

To inculcate this doctrine, that the foul would fuffer for fome time in another world, if the body were not decently buried in this, and that the neglect of the funeral ceremonies is offenfive to fuperior beings, was a very warrantable fraud in the lawgivers of Greece and Egypt; as it would no doubt make the people attentive to a duty, whereof we find that favage nations are too apt to be forgetful.

OUR two adventurers were now approaching the river, when Charon the ferryman, alarmed at the fight of a living man in complete armour, called to the Trojan to ftop, and give an account of himfelf. The Sybil pacified Charon, by declaring the name and quality of her fellow-traveller, and fhowing the golden bough. They were then ferried over; and the three-headed dog Cerberus, preparing to attack them, was quieted with a cake which the prieftefs had got ready for him, and which he had no fooner fwallowed than he fell faft afleep.

WHAT could have given rife to this fable of Charon and his boat, it is not very material to enquire. Mythological writers

have

have ſaid, That the Greeks learned it from the Egyptians, which is indeed probable enough; that the Egyptians framed both this, and ſome other fables relating to the dead, from certain cuſtoms peculiar to their country; that in particular there was, not far from Memphis, a famous burying-place, to which the dead bodies were conveyed in a boat acroſs the lake Acheruſia; and that Charon was a boatman who had long officiated in that ſervice. The learned Dr BLACKWELL ſays, in his life of HOMER, that, in the old Egyptian language, *Charoni* ſignified ferryman.

THE travellers had now before them a region which the poet calls *lugentes campi*, extending from the other ſide of the Styx to the road that leads to Elyſium on the right hand, and that which terminates in Tartarus on the left. Theſe melancholy plains muſt not be confounded with Tartarus. The latter is a place of eternal torment, prepared for thoſe who, in this world, had been guilty of great crimes; for there, ſays the poet, "Sedet, *æternum*que ſedebit infelix Theſeus." The former, though an uncomfortable region, is not a place of endleſs puniſhment, but a ſort of purgatory, in which all thoſe ſouls that are not conſigned to Tartarus, are doomed to undergo certain purifying pains, to prepare them for Elyſium. Theſe pains are more or leſs ſevere, and of longer or ſhorter duration, according to the degree of guilt committed in the upper world. The ſouls, on paſſing the Styx, appear before the judge Minos, who ſummons a council, either of ghoſts or of infernal deities, but whether as a jury, or as witneſſes, we know not; and having informed himſelf of the lives and characters of thoſe who are brought before him, allots to each a ſuitable manſion in this purgatory.

THE ſouls thus diſpoſed of, are—*firſt*, thoſe of good men, who, after undergoing the neceſſary pains of purification, paſs into Elyſium, where they remain in a ſtate of happineſs for ever; *2dly*, of thoſe who have been of little or no uſe to mankind;

kind; *3dly*, of thoſe who have been cut off by an untimely death, ſo that their real characters could not be exactly aſcertained; *4thly*, of thoſe who, though guilty of crimes, had not committed any thing very atrocious; and, *laſtly*, of thoſe whoſe crimes, though atrocious, were conſidered as the effects, rather of an unhappy deſtiny, than of wilful depravation.

THAT the ſouls of good men, who were to have an eternal abode in Elyſium, were previouſly obliged to undergo purgation by ſuffering, is not expreſsly declared, but may be inferred from what ANCHISES ſays, "Quiſque ſuos patimur manes:" "every one of *us* undergoes what is inflicted on him by his "*manes*;" that is, by thoſe deities of the nether world who were the diſpenſers of expiatory puniſhment. This is the original, or at leaſt the moſt uſual ſenſe of the word *manes*, which, however, ſometimes denotes metonymically the infernal regions in general, and ſometimes, but more rarely, the ſouls or ſhades who inhabited thoſe regions. In Tartarus, it does not appear that the Manes had any thing to do. The diſpenſers of puniſhment in that dreadful place were Tiſiphone and her ſiſter-furies. The Manes muſt have been a gentler ſort of beings. Some derive the word from *manus* or *manis*, which they ſay (on what authority I know not) is an old adjective ſignifying *good*. The invocations of the Manes practiſed at funerals, the altars that were erected to them, and thoſe monumental inſcriptions which began with the words *Dis Manibus*, were all, no doubt, intended as acts of worſhip, or as compliments, to theſe deities, and ſuppoſed to incline them to mercy in their treatment of the perſons deceaſed, whoſe ſouls were now in their hands in purgatory. HORACE tells us, that the Manes, as well as the gods above, might be rendered placable by ſong—"Carmine di ſuperi "placantur, carmine manes." But the furies were inexorable and mercileſs—"Neſciaque humanis precibus manſueſcere corda." And I do not find that worſhip, or any other honours, were, except by witches *, paid them, though to mother Midnight, whoſe daughters

* HOR. Sat. I. 8. v. 33.

daughters they were, ſacrifice was occaſionally performed. OVID ſays indeed, that they relented on hearing the ſong of Orpheus, but aſſures us it was for the firſt time. VIRGIL, in his account of that affair, ſays only, that they were aſtoniſhed.

HERE I cannot but remark how abſurd it is for *us* to begin an epitaph with the words *Dis Manibus*, or the letters *D. M.* which oftener than once I have ſeen on a modern tombſtone. Such an exordium may be claſſical; but, in a Chriſtian church-yard, an invocation to Proſerpine would not be more incongruous. ADDISON did well, when he adviſed the writers of his time not to ſacrifice their catechiſm to their poetry.

I SAID, that the Manes ſeem to have had nothing to do in Tartarus. I am not ignorant, however, that RUEUS and the common Dictionaries affirm, that the word ſometimes denotes the furies, and quote as an authority, " Ignoſcenda quidem, " ſcirent ſi ignoſcere manes." But this is not ſufficient authority. That verſe of VIRGIL relates to Orpheus looking behind him, when conducting his wife to the upper world; a fault, or infatuation, which was to be puniſhed, not by the ſcourge of the furies, but by calling back Eurydice to the ſhades below; and which the Manes, however placable, could not pardon, becauſe it was a direct violation of the treaty with Proſerpine.

IT is ſomewhat difficult to underſtand diſtinctly what the ancients meant by the words *animæ*, *umbræ*, *ſimulacra*, which, in this diſcourſe, I call *ghoſts*, *ſhades* or *ſouls*. *We* know, that man conſiſts of a body and a ſoul, a material and an incorporeal part; the one, like all other bodies, inactive, the other the ſource of life, motion and intelligence. But, on comparing the general doctrine of this ſixth book with a paſſage in the fourth Georgic, and with the eleventh of the Odyſſey, we find, that our poet, following in part the opinions of PYTHAGORAS and PLATO, and partly too the repreſentations of HOMER, ſuppoſed man to conſiſt of three ſubſtances; *firſt*, a vital and active

tive principle, derived either from the Deity himſelf, or from that univerſal ſpirit whom he created in the beginning, who animates all nature, and of whom the vital principle of brutes is alſo, according to VIRGIL, an emanation; 2*dly*, a ſhade or ghoſt, *umbra*, *anima*, *ſimulacrum*, or *εἴδωλον*, as HOMER calls it; and 3*dly*, a body. At death, the vital principle was re-united to that univerſal ſpirit whereof it was originally a part; the body was burned or buried, and returned to the earth whence it came; and the ſhade or ghoſt went to the nether world, and appeared before Minos or Rhadamanthus, who aſſigned it ſuch a manſion of happineſs, of torment, or of expiatory ſuffering, as the perſon's behaviour on earth had merited, or his circumſtances with reſpect to pollution or purity required. Theſe ſhades or ghoſts were ſo far corporeal as to be viſible, but could not be touched; they retained the ſame appearance their bodies had before death; they had reaſon and ſpeech and conſciouſneſs, and a remembrance of their paſt lives; they could be happy or unhappy; retained all the paſſions and affections of humanity; and were capable (ſuch of them at leaſt as had not been atrocious criminals) of being purified from the pollutions of guilt by the operation of air, fire and water.

THAT part of the *lugentes campi* which ENEAS firſt paſſed through, after croſſing the Styx, was peopled by the ſhades of infants, of perſons who had ſuffered death by a falſe accuſation, and of thoſe who had taken away their own lives. Theſe are all placed in the ſame neighbourhood, probably becauſe, having been cut off, as we ſay, before their time, they had not had the means, while on earth, of diſplaying their character in its full extent. This, however, is but conjecture; for the poet only mentions the circumſtance, without aſſigning a reaſon. The ſelf-murderers, who occupy this diſtrict, are termed *inſontes*, innocent or harmleſs; an epithet which the commentators do not underſtand, or at leaſt do not ſee the propriety of in this place. VIRGIL, we are ſure, did not mean to inſinuate, that

self-destroyers in general are guilty of no fault; for he places even these *insontes*, who in respect of others were comparatively innocent, in an uncomfortable situation, and says, that they would now return to the earth if they could, and willingly submit to poverty, and those other evils, which when alive they thought insupportable. By the word *insontes*, therefore, as here applied, I understand such unhappy persons as had destroyed themselves, without being chargeable with any other great wickedness. Had they been guilty of impiety, injustice, want of natural affection, or any gross immorality, they would, according to our author's plan of retribution, have been consigned to everlasting punishment in Tartarus. But as we find them in a state of expiatory suffering, and characterised by this epithet, we must, I think, suppose, that the poet here speaks of that self-destruction, which, being partly the effect of infirmity, was, in his judgment, the object of pity as well as of disapprobation.

THE Trojan and his guide were now arrived at that part of the melancholy plains, where the country, if I may call it so, seemed to open into a wider extent. Here was a district, where, in a myrtle grove, were wandering the shades of unhappy lovers. Here ENEAS met with DIDO, who had rejoined her husband SICHEUS; and here he saw several others, some of whom, by the by, had led such lives on earth as would seem to deserve a severer doom than that of VIRGIL's purgatory.

ADJOINING to the grove of lovers, and at the furthest extremity of these regions, was a province inhabited by deceased warriors. Here he found several of his old acquaintance, who were glad to see him, and converse and walk with him, and curious to know the occasion of his coming. The Grecian ghosts knew him likewise, and fled from before him, as they had been accustomed to do in the Trojan war. Here he saw the shade of his brother-in-law DEIPHOBUS, in the same mangled condition in which his body had been left by the Greeks in the night

night of the burning of Troy. A long conversation ensued between the two friends, which was at last interrupted by the priestess, who told ENEAS that he had no further time to lose. Be not angry, said DEIPHOBUS; I shall go away, return to my darkness, and there complete my term of penance.

Discedam, explebo numerum, reddarque tenebris.

The words *explebo numerum* are variously interpreted; but the sense is probably what is here given. RUEUS is inclined to explain it thus, "Be not angry, great priestess, I shall just wind "up the last period of my discourse, and then return to my "darkness;" as if the poor mangled ghost of DEIPHOBUS had been ambitious to distinguish itself at this time as a rhetorician, and well skilled in the art of rounding a period. DRYDEN understands the passage as I do. SERVIUS hints at the same interpretation, but seems to prefer another.

THE two travellers having passed through the melancholy plains, were now come to a place, where one road went off to the left, and another to the right; the former leading to Tartarus, the latter to Elysium. They were going to Elysium on a visit to ANCHISES: but before they struck off to the right, the priestess took this opportunity to describe Tartarus, the gates of which were in view, but which ENEAS could not enter, as they were never opened but for the reception of those wicked souls, whom the judge Rhadamanthus, after making them confess the crimes they had committed in the upper world, thought proper to condemn to eternal punishment. When this dreadful sentence was passed, they were seized on by Tisiphone and the other furies, the adamantine gates opened with a tremendous sound, and the criminals were thrown into an immense dungeon, stretching downwards twice as far as from hell to heaven.

The deſcription of Tartarus is wrought up in a ſtyle of terrible ſublimity, ſuch as never was equalled by any other poet, except by Milton, in the firſt and ſecond books of Paradiſe Loſt. In the intrinſic grandeur of his images, the Engliſh poet may be thought to have excelled the Roman; but in one reſpect the Roman has the advantage. By means of a more muſical language, he has been enabled to embelliſh his narration with a ſonorous magnificence of harmony, whereof the Engliſh tongue, even when modulated by Milton, is not ſuſceptible.

The mouth of the Tartarean gulf was encircled with three walls ſo ſtrong, as to be proof againſt every aſſault of men or gods; and theſe walls were ſurrounded by Phlegethon, a river of tempeſtuous flame. Sleepleſs, before the gate, day and night, and full in Eneas's view, ſat the fury Tiſiphone in bloody attire. From within iſſued ſuch an uproar of terrifying noiſes, that the hero, though at a diſtance, heard it with horror; the cries of the tormented, the ſound of the ſcourge, the craſh of iron-engines, and the clanking of chains dragged along. Tell me, ſaid he, O virgin, what clamours, what puniſhments, are thoſe; and for what crimes they are inflicted. This gives the prieſteſs occaſion to deſcribe what was paſſing in the regions of torment; with which Hecate had made her acquainted, when ſhe gave her the ſuperintendence of the groves of Avernus. The perſons there puniſhed had all perpetrated enormous crimes; among which are reckoned, acts of impiety, want of natural affection, cruel treatment of parents, the defrauding of clients or dependants, and the hoarding up of wealth to the injury of friends and relations. Here too adultery is puniſhed, even though the criminal ſhould have already ſuffered death for it in the upper world. Other crimes here puniſhed are, rebellion, inceſt, the various ſorts of injuſtice and treachery, the venality of lawgivers, ſubverſion of the liberties of our country, ſacrificing the public good to private intereſt,

and

and many other forms of wickedneſs, whereof the Sybil declares it was impoſſible for her to give a particular enumeration.

THE puniſhments are various. Of one enormous offender, the entrails are continually devoured by a vulture, and continually growing to be again devoured; an apt emblem to expreſs the pangs of a guilty conſcience, and which puts one in mind of the never-dying worm mentioned in Scripture. Some are in the eternal apprehenſion of being cruſhed by a black rock, which hangs over them, and ſeems to be every moment beginning to fall. Some are perpetually employed in rolling a huge maſs of ſtone; ſome are ſtretched out on a whirling wheel; and ſome, agoniſing with eternal hunger, have a ſumptuous banquet ſet before them, which they no ſooner attempt to touch, than a gigantic fury ſtarts up, brandiſhing a torch, and denouncing vengeance in a voice of thunder.

THERE is nothing in VIRGIL more explicit than the account of Tartarus; and I know not why it has been ſo generally miſunderſtood. Dr WARBURTON ſays, in one place, that ENEAS ſaw the ſights of Tartarus at a diſtance, and, in another, that ENEAS paſſed through Tartarus. In fact, he did neither. He could not paſs through without entering; and this, we are told, was to him impoſſible: "Nulli fas caſto ſceleratum inſiſtere "limen." And though he had been permitted to enter, he could not paſs through, without firſt croſſing a river of fire, and then deſcending into an immenſe gulph, twice as deep beneath the level of the other regions of darkneſs, as thoſe are remote from heaven. It was equally impoſſible for him to ſee from a diſtance what was doing in ſuch a gulph, even though the gate that led to it had been open, which, however, at this time, happened to be ſhut. "You ſee, ſaid the Sybil, what a "centinel ſits without in the porch, (meaning Tiſiphone); "another, ſtill more dreadful, has her ſtation within;" which, as he could not ſee it, ſhe informs him is a huge ſerpent, or hydra, with fifty heads. An opening of the gate is indeed mentioned,

mentioned, which RUEUS understands to have taken place at the very time when the Trojan and the Sybil were looking at it. But that is a mistake. The Sybil only tells her companion, that, when Rhadamanthus has made the criminals confess their guilt, then at length (*tum demum*) the gate opens for their reception into the place of torment. It is strange that RUEUS and Dr WARBURTON did not see that this is the obvious import of the words of VIRGIL; and that, if we do not understand them in this sense, the passage must appear confused, if not ungrammatical. In a word; of the inside of Tartarus the Trojan hero saw nothing; he saw the outside only, the walls, the gates, the tower of iron, *&c.* and these he saw at some distance. What was passing within he learns from the Sybil's information.

"AND now, says she, let us be going. Yonder, on the "right hand, is the palace of Proserpine, where, in the vaulted "porch that fronts us, we are commanded to deposit the golden "bough." This ceremony ENEAS performs, after having sprinkled himself with pure water; which was customary with those who made offerings to the gods.

THEY then went onward to Elysium, the gay scenery of which, immediately succeeding the gloom of purgatory and the horrors of Tartarus, is so charming, that every reader feels himself refreshed by it. Here were groves, and plains, and meadows, clothed with perpetual verdure, the abodes of tranquillity and joy, and illuminated by a sun and stars of the most refulgent beauty. Here were feasting, and dancing, and music, and poets accompanying their verses with the harmony of the lyre. Here those warlike exercises were renewed, in which the heroes while on earth had so much delighted; and here were horses, and chariots, and arms, and every thing that could gratify an heroic mind. It must be owned, that all this is very inadequate to the desires and the capacity of an immortal soul:

foul; but VIRGIL had heard of nothing better; and it was impoſſible for him to deſcribe what he could not conceive.

IN this Elyſium, which, with all its imperfection, is, as well as the infernal world, founded on the beſt ideas of retributive juſtice that could be expected from a pagan, the poet places, in a ſtate of endleſs felicity, "the ſhades of the pure and the "pious; of heroes who have died in defence of their country; "of ingenious men who have employed their talents in adorn-"ing human life with elegant arts, or in recommending piety "and virtue; and of all who, by acts of beneficence, have "merited the love and the gratitude of their fellow-creatures."

To a company of theſe happy beings, who had flocked round the two ſtrangers, and eſpecially to the poet MUSEUS, whom ſhe knew, the Sybil addreſſed herſelf, deſiring to be informed where ANCHISES reſided. We have no certain habitations, returned the poet; we wander about, and amuſe ourſelves, wherever we pleaſe; but follow me to yonder riſing ground, and I ſhall put you in a path that will conduct you to him.

SOME writers blame VIRGIL for not making ENEAS find HOMER in this part of Elyſium; and inſinuate, that the Roman poet muſt have been both invidious and ungrateful, in neglecting ſuch an opportunity of doing honour to his great maſter, to whom he owed ſo much. Thoſe critics do not conſider that ENEAS was dead an hundred years before HOMER was born. Our poet has been cenſured for a *ſuppoſed* anachroniſm, in making ENEAS and DIDO contemporary; and here he is found fault with for having judiciouſly avoided a *real* anachroniſm.

IT chanced that ANCHISES was at this time in a remote valley, reviewing, in their ſtate of pre-exiſtence, ſome of his poſterity, who were afterwards to diſtinguiſh themſelves in the Roman republic. When he ſaw his ſon advancing towards him, he held forth both his hands, gave him an affectionate welcome, and wept for joy. The hero would have embraced his fa-

ther;

ther; but found that the ſhade, though viſible, eluded the touch.

AFTER a ſhort converſation, ENEAS happening to ſee, in a grove through which a river was flowing, an innumerable multitude of human beings flying about, aſked his father who they were, and what river it was. The river, ſaid he, is Lethe, of which thoſe ſouls are taking a draught, being about to return to the upper world, in order to animate new bodies. Is it to be imagined, exclaims ENEAS, that ſouls ſhould ever leave this happy place, and go back to the impriſonment of the body, and all the wretchedneſs of mortality? I will explain the whole matter to you, replies ANCHISES.

KNOW, then, that all the parts of this viſible univerſe, the heavens, and earth, and ſky, the ſun, moon, and ſtars, are, like one vaſt body, animated by an univerſal ſpirit, whereof the ſouls, or vital principles, of all animals, of men and beaſts, of fiſhes and fowl, are emanations. This vital principle is, in every animal, the ſource of ſenſation and motion; but, from the influence that the body has over it, becomes ſubject to inordinate paſſions, and forgetful of its heavenly original. The ſoul of man, in particular, (for nothing further is ſaid of the other animals) contracts, while ſhut up in the dark priſon of the body, a degree of debaſement which does not leave it at death, and from which the ſufferings of a ſubſequent ſtate of purgation are neceſſary to purify it. Theſe are of different kinds and degrees, according to the different degrees and kinds of guilt or impurity which the ſoul has contracted. Some ſouls are expoſed to the beating of winds, ſome are waſhed in water, and ſome purified by fire. Every one of *us* (ſays ANCHISES, including himſelf) ſuffers his own peculiar pains of purification. Then we are ſent into this vaſt Elyſium, and a few of us remain in the eternal poſſeſſion of it *. The reſt continue here,

* I ſuppoſe the words *Et pauci læta arva tenemus*, to be a parentheſis; which, in my opinion, clears the text of all obſcurity. By the change of the perſon, in the four laſt lines

here till, by the air and tranquillity of the place, they have entirely got the better of the impurity contracted in the world, have had every impreſſion of the pains of purgatory worn out, and are reſtored to their original ſimplicity of nature. Thus refined, they are, at the end of a thouſand years †, ſummoned by a divine agent, or god, to meet in one great aſſembly, where they drink of Lethe to waſh away remembrance, and then, in compliance with their own inclination, are ſent back to the earth to animate new bodies.

HAVING ended this account, ANCHISES, with his ſon and the Sybil, paſſes to a riſing ground, and points out, in a ſtate of pre-exiſtence, a proceſſion of Roman heroes, who were in due time to deſcend from him; briefly deſcribing their ſeveral characters, in a moſt ſublime ſtrain of poetical prophecy.

I SHALL ſubjoin a few remarks on the concluding ſcene of this noble epiſode;—on the gates of horn and ivory. Theſe gates have given no little trouble to critics, both ancient and modern; who, after all, ſeem to have been not very fortunate in their

lines of the ſpeech,—*Has omnes,—volvere,—incipiant,—reviſant,* it appears, that ANCHISES does not include himſelf among thoſe who were to return to the world; which aſcertains ſufficiently the import of *tenemus.* The learned RUEUS conſtrues the paſſage in a way ſomewhat different; but his general account of the poet's doctrine differs not eſſentially from mine.

† MORE literally, "When they have rolled the wheel, or circle, for a thouſand "years;" that is, when the revolution of a thouſand years is completed. For this interpretation we are indebted to SERVIUS, who tells us further, that this ſingular phraſe was taken from ENNIUS. Anciently perhaps *rota* might mean a *circle,* (as well as a *wheel,*) and poetically a *year*; ſo that, in ENNIUS's time, *volvere rotam* might be a figurative phraſe of the ſame import with *annum peragere, to paſs a year.* The original meaning of *annus* is *a circle,* whence the diminutive *annulus, a ring.* The ſame reference to the circular nature of the year, may be ſeen in the Greek ἐνιαυτὸς, which VIRGIL certainly had in his mind when he wrote, "Atque *in ſe* ſua per veſtigia volvitur annus." When this is attended to, our author's uſe of the phraſe in queſtion will appear not ſo harſh as it might otherwiſe be thought to be, and not at all too figurative in this very ſolemn part of the poem.

conjectures. This is owing, not to obſcurity in the poet, but to the refinement of thoſe interpreters, who miſtook a plain paſſage for a profound allegory, and were determined to find a ſecret meaning in it. The gate of ivory, ſay they, tranſmits falſe dreams, and that of horn true ones; and ENEAS and his companion are diſmiſſed from Elyſium, and let into the upper world, through the ivory gate. What can this imply, but that the poet meant to inſinuate, that every thing he had ſaid concerning a ſtate of future retribution, was nothing more than a fallacious dream? And, in ſupport of this conjecture, they generally quote from the Georgic three verſes to prove, that VIRGIL was in his heart an Epicurean, and conſequently diſbelieved both a future ſtate and a providence. The verſes are—
"Felix qui potuit rerum cognoſcere cauſas, Atque metus om-
"nes, et inexorabile fatum, Subjecit pedibus, ſtrepitumque
"Acherontis avari."

Now, in the *firſt* place, it does not appear to me, that theſe lines can prove their author ever to have been an Epicurean, or that he meant to ſay more than "Happy is the man whoſe mind philoſophy has raiſed above the fear of death, as well as above all other fears." For, in the Georgic, he not only recommends religion and prayer, which Epicureans could not do conſiſtently with their principles, but again and again aſſerts a providence; and, in terms equally elegant and juſt, vindicates the Divine wiſdom in eſtabliſhing phyſical evil as the means of improving and elevating the mind of man. But does he not, in his ſixth eclogue, give an account of the formation of the world according to the Epicurean theory? He does; and he makes it part of the ſong of a drunkard: no proof that he held it in very high eſteem.

BUT, 2*dly*, Suppoſing our poet's admiration of LUCRETIUS might have made him formerly partial to the tenets of EPICURUS, it does not follow that he continued ſo to the end of his life,

life, or that he was ſo while employed upon the Eneid. The duties of religion, and the ſuperintending care of providence, are by no other Pagan author ſo warmly enforced as in this poem; and the energy with which, in the ſixth book, and in one paſſage of the eighth, (v. 666.) he aſſerts a future retribution, ſeems to prove, that he was ſo far in earneſt with regard to this matter, as to believe, that it was not, as the Epicureans affirmed, either abſurd or improbable.

LET it be remarked, in the *third* place, that no poet ever thought of ſo prepoſterous a method of pleaſing and inſtructing his readers, as firſt to employ all his ſkill in adorning his fable, and then tell them, that they ought not to believe a word of it. The true poet's aim is very different. He adapts himſelf to the opinions that prevail among the people for whom he writes, that they may the more eaſily acquieſce in his narrative; or he is careful, at leaſt, to make his fable conſiſtent with itſelf, in order to give it as much as poſſible the *appearance* of ſerіouſneſs and truth. *We* know, that the ſcenery of the ſixth book is wholly fictitious; but the Romans did not certainly know how far it might be ſo: founded as it was on ancient tradition, which no hiſtory they had could overturn; and on philoſophical opinions, which they had never heard confuted, and which, where Revelation was unknown, might ſeem reſpectable, on account of the abilities of PYTHAGORAS, PLATO, and other great men who had taught them.

To which I may add, *4thly*, as an argument deciſive of the preſent queſtion, That if VIRGIL wiſhed his countrymen to believe him to have been *not* in earneſt in what he had told them of a pre-exiſtent and future ſtate, he muſt alſo have wiſhed them to underſtand, that the compliments he had been paying to the moſt favourite characters among their anceſtors were equally inſincere; and that what he had ſaid of the virtues of CAMILLUS, BRUTUS, CATO, SCIPIO, and even AUGUSTUS himſelf, was altogether viſionary, and had as good a right to a paſſage

through the ivory gate, as any other falsehood. Had OCTAVIA understood this to be the poet's meaning, she would not have rewarded him so liberally for his matchless encomium on the younger MARCELLUS. Had this indeed been his meaning, all the latter part of the sixth book would have been a studied insult on AUGUSTUS, and the other heroes there celebrated, as well as on the whole Roman people. Strange, that the most judicious writer in the world should commit such a blunder in the most elaborate part of a poem which he had consecrated to the honour of his country, and particularly to that of his great patron AUGUSTUS!

WE must therefore admit, either that VIRGIL had lost his senses, or, which is more probable, that, in sending ENEAS and the Sybil through the ivory gate, he intended no sarcastic reflection either on his country or on his poetry. In a word, we must admit, that, in this part of his fable, he was just as much in earnest as in any other; and that there was no more *joke* in ENEAS's *ascent* through the gate of ivory, than in his *descent* through the cave of Avernus. How then are we to understand this adventure of the gate? I answer, By making the poet his own interpreter, and not seeking to find things in his book which we have no good reason to think were ever in his head.

IN the nineteenth book of the Odyssey, Penelope, speaking of dreams, says to her nurse, that there are two gates by which they are transmitted to us; one made of horn, through which the true dreams pass, and the other of ivory, which emits false dreams. This thought HOMER probably derived from some Egyptian custom or tradition, which one might discuss with many quotations and much appearance of learning; and this, no doubt, gave VIRGIL the hint of the passage now before us. But VIRGIL's account differs from HOMER's more than the commentators seem to be aware of. HOMER does not say in what part of the world his gates are; VIRGIL's are in Italy, not far from Cumæ, and are said to be the outlet from Elysium

Elyſium into the upper world: a wild fiction no doubt, but not more wild than that of making the cave of Avernus the inlet from the upper world into the nether. HOMER's gates are the gates of dreams; VIRGIL calls his the gates of ſleep. The former are not ſaid to tranſmit any thing but dreams; of the latter, one tranſmits dreams, and the other *real ghoſts* or *ſhades*. For thus, though all the commentators are againſt me, I muſt underſtand the words *umbris veris;* becauſe in VIRGIL *umbra* often ſignifies a *ghoſt*, but never in him, nor in any other good writer, (ſo far as I know) a *dream*. If it be aſked, what ghoſts they were that uſed to paſs this way; the anſwer is eaſy: they were thoſe who, after having been a thouſand years in Elyſium, and taken a draught of Lethe, were ſent back to the upper world to animate new bodies. If again it were aſked, whether ſuch beings might not be of ſo ſubtle a nature as to work their way into the upper world without paſſing through a gate; I ſhould anſwer, that viſible ſubſtances, which might be purified by fire, or waſhed in water, and could not get over the river Styx but in a boat, muſt be ſo far material at leaſt, as to be capable of confinement, and conſequently of being ſet at liberty.

THE *falſa inſomnia* that go out by the ivory gate may mean, either *deceitful dreams*, or *dreams in general*, that is, unſubſtantial things, as oppoſed to realities; which laſt I take to be the preferable ſignification. Be this, however, as it will, ENEAS and the Sybil were neither ghoſts nor dreams, but human fleſh and blood; and could no more be ſuppoſed to partake of the qualities alluded to in the *name* of the gate by which ANCHISES diſmiſſed them, than a man is ſuppoſed to be lame for having paſſed through Cripplegate, or than the Lord Mayor of London, by entering in proceſſion through *Temple*-bar, is ſuppoſed to have become a better churchman than before, or a better lawyer. Through one or other of the gates of ſleep the Trojan and his guide muſt paſs, or they never could return to the upper world:

world at all: and that gate the poet probably made choice of, which first occurred to him; and that probably would first occur which sounded best in his verse: or perhaps one might say, in the way of conjecture, that he thought fit to open the ivory gate, because the other, being appropriated to the purified ghosts, might not be so well suited to mere mortals. This is certain, that, though the ablative *eburna* stands very gracefully in the 898th line, the ablative *cornea* could not; because, being the foot *amphimacer*, it can have no place in a regular hexameter.

As to the analogy that some critics have fancied between horn and truth, and between falsehood and ivory, it is so whimsical, and so absurd, that I need not mention it.

AND now, by removing the mist of allegory from VIRGIL's gates, I flatter myself, that I have made these verses somewhat more intelligible than they have been generally supposed to be; that I have proved the latter part of this episode to be consistent with the rest of it; and that I have vindicated a favourite author from the heavy charges of impiety and ill-manners, whereof, however repugnant to his general character, it would not be easy for those to clear him who follow the common, though less obvious, interpretations.

III.

III. *An* Essay *on* Rythmical Measures. *By Walter Young*, M. A. F. R. S. Edin. *and Minister of the Gospel at Erskine.*

[*Read by Mr* John Robison, *Dec.* 18. 1786.]

MAN is formed to derive pleaſure from a variety of different ſources. Many of his pleaſures are communicated by the channel of the external ſenſes. Each of theſe has particular claſſes of objects that are ſuited to its gratification; and theſe, being diffuſed in great abundance through the works of nature, or framed by the art and ingenuity of men, become to him a ſource of frequent and diverſified enjoyment.

The pleaſures which we receive through the ſenſes of ſeeing and of hearing have ever been accounted of a nobler and more dignified nature than thoſe which we receive by means of the other ſenſes. They are intimately connected with, and ſeem, in a great meaſure, to depend upon, certain higher faculties of human nature, which have ſometimes been called internal ſenſes. A ſenſibility to them is poſſeſſed by different men in very different degrees, and confers upon ſome men a real ſuperiority to others: The inferior animals do not appear to be, in any degree, poſſeſſed of it. It is ſuſceptible of cultivation and improvement. The man, therefore, who poſſeſſes it in a high degree, whilſt he has an exquiſite enjoyment of all the pleaſures which are peculiar to thoſe ſenſes, derives, at the ſame time, an additional ſatisfaction from the flattering conſciouſneſs, not only that he is exalted above the inferior animals, but that he is

more

more perfect in his kind, and more highly improved, than many who belong to his own ſpecies. Accordingly, theſe pleaſures have, in all ages, been ſought after with eagerneſs. Men of the greateſt abilities have employed themſelves in tracing out their nature, inveſtigating the different internal ſenſes upon which they depend, and diſcovering the various objects that are ſuited to communicate them. The greateſt efforts of human ingenuity have been directed to obtain theſe objects, and to preſent them in their moſt perfect ſtate.

Among the internal ſenſes upon which theſe pleaſures are found greatly to depend, the perception of order and proportion ſeems to have a principal place. Order and proportion are generally diſcovered, in a certain degree, in every thing that communicates immediate pleaſure, either to our ſight or hearing. When, from any particular circumſtance, they happen not to be perceived, the pleaſure is always greatly abated; in ſome caſes it is altogether deſtroyed. That ſome kind of arrangement and proportion of parts is eſſential to every thing which is accounted beautiful, is generally acknowledged. Leſs doubt can be entertained with regard to the objects of hearing. It is an eſtabliſhed fact, that no ſounds can give great pleaſure to the ear, unleſs they are related to one another according to certain proportions, and are diſpoſed in a certain order. It is equally eſtabliſhed, that when ſounds in ſucceſſion are ſo related, the pleaſure which they afford is very imperfect, unleſs their reſpective durations are regulated according to certain meaſures. Mankind are greatly diverſified with regard to the power which they poſſeſs of perceiving theſe relations. Some men have that power in a much higher degree than others. Some men have a very nice perception of theſe relations in one claſs of objects, while they ſeem to be ſcarcely ſenſible of them in other claſſes. Theſe differences amongſt men are undoubtedly owing in a great meaſure, to habit and cultivation. They ſeem,

feem, however, to depend alfo, in a confiderable degree, upon natural conftitution.

I HAVE obferved, that, in an agreeable fucceffion of founds, order and proportion take place in two different ways. Upon the one depends what is called the tone of the feveral founds, or the relation which they bear to one another with refpect to acutenefs and gravity; upon the other depends what is often called their rythm, cadence or meafure. The latter of thefe is probably the moft important. It feems to be indifpenfably required in every agreeable fucceffion of founds. A feries of notes, proportioned in tone with the utmoft nicety, and arranged with the greateft art, if no meafure or proportional duration is obferved in them, will communicate no pleafure, but, on the contrary, will create difguft. On the other hand, a feries of founds juftly proportioned in duration, and artfully difpofed, will always give pleafure, although every one of them fhould be expreffed in the fame tone, and even although they fhould be expreffed in different tones, the proportions of which cannot be perceived by the ear. The beating of a drum is agreeable to the ear, and fometimes has a confiderable effect upon the mind. The fyllables which compofe words differ in length according to certain proportions, which may be felt by the ear. Words, therefore, may be arranged in rythm. When this arrangement is made with art, the rythm is agreeable, even when it is expreffed in the tones of fpeech in which no mufical proportion is perceived. Again, though men poffefs, in different degrees, the power of feeling the proportional duration of fucceffive founds, and of relifhing an agreeable rythm, there is perhaps no man altogether deftitute of it. On the other hand, mens power of perceiving the mufical relations of founds, and of relifhing an artful combination of them, is much more diverfified. The differences among them in this refpect are wider and more ftriking. In fome men, that power is fcarcely difcernible, who neverthelefs may be able to judge of rythm

 with

with accuracy, and to enjoy it with ſenſibility. From this circumſtance, too, we are led to conclude, that of theſe two powers, that by which we perceive and enjoy rythm is of greateſt importance to our gratification.

TONE is the province of the muſician alone. Rythm is equally the province of the muſician and the poet. It is alſo, in ſome degree, an object of attention to the orator and proſe writer. Although the general principles and foundations of rythm, as it takes place in the works of theſe different artiſts, may be nearly the ſame, the particular application of theſe, and the extent to which it is carried by each of them, are different. It may accordingly be diſtinguiſhed into three kinds, *viz.* muſical, poetical and proſaic.

IT is propoſed, in the following Eſſay, to endeavour to inveſtigate ſome of the leading principles of the two firſt kinds of rythm, the muſical and the poetical, and afterwards to ſubjoin ſome additional remarks and illuſtrations upon each of them.

AMONGST the ancients, muſic was ſeldom or never uſed but as an auxiliary to poetry. Its rythm, therefore, was regulated, in a great meaſure, by that of the poetry to which it was adapted. Amongſt the moderns, too, muſic and poetry are frequently united; and by this union their greateſt effects are produced. As, however, muſic has been greatly cultivated and improved by the moderns, it is enabled alſo to ſubſiſt alone, and in that ſituation to produce very pleaſing effects. In this ſeparate ſtate it will be proper to conſider it at preſent. And here it will readily occur, that variety, within certain limits, is neceſſary to muſical rythm. In poetry, the proportion in duration of ſingle contiguous ſounds ſeldom exceeds that of two to one. This proportion does not admit of great variety. When a poem, however, is recited, the attention of the hearer is chiefly engaged by the ſentiments, the images and the diction. The rythm is frequently conſidered only as an accidental grace, which we are led by habit to expect in every compoſi-

tion

tion that bears the name of poetry. In muſic, on the other hand, a principal part of the pleaſure to be communicated muſt depend upon the rythm; and therefore in muſic other proportions in duration, beſides that of two to one, muſt be admitted.

In order then that theſe proportions may be felt, and that uniformity may be perceived amidſt this variety, it is neceſſary that the duration of the ſucceſſive ſounds be regulated according to ſome fixed ſtandard or meaſure, which may be obvious to the hearer. This ſtandard muſt be a determined portion of time, of which every ſound muſt be either an aliquot part or a multiple.

Time is a meaſurable quantity, or may be conſidered under the ideas of equal, or of greater and leſs. Moſt men are capable of perceiving equal intervals of time, provided thoſe intervals do not exceed a certain magnitude. When we hear a number of ſucceſſive ſtrokes, we can generally determine whether the intervals betwixt them are equal or unequal. We acquire this idea of equal intervals of time, from the motion of our own limbs, and of thoſe of other animals, in walking or flying, which nature, for the purpoſes of eaſe and grace, has determined to be an uniform motion. We acquire the ſame idea from the movement of pendulums, and from the beating of clocks and watches. By a habitual attention to theſe, men come by degrees to have a very accurate perception of ſmall equal intervals of time.

When we have fixed our attention upon any ſuch interval, and conſider it as an unit of time, we can ſuppoſe it divided into a certain number of equal parts; and by motion we actually can make ſuch a diviſion. When we ſtand beſide a clock, we can, with great eaſe, make a certain number of uniform or equal timed ſtrokes in the intervals betwixt the ſeveral beats. This power of diviſion, however, has its limits. Although we may conceive an interval to be divided into any number of

equal parts, the number of parts into which we actually can divide it muſt depend upon the powers which we have of performing quick motions. Theſe powers are very limited. The roll of a drum, the moſt rapid movement of a muſician upon an inſtrument, does not divide a ſecond of time into much more than ſixteen or eighteen equal parts, hardly ever into twenty-four. Our power of dividing a ſmall interval of time, equally and uniformly, and of perceiving ſuch a diviſion by the ear, is alſo confined to certain proportions. The ſimpleſt and the eaſieſt diviſion is into two, or any of its powers which are within the limits of practicability. We can divide an interval into two or into four equal parts with almoſt the ſame eaſe. Having obtained either of theſe diviſions, we can alſo conſider each of the parts as an unit, and ſubdivide it into two or four, thus making a diviſion into eight, or, if our powers of quick motion will admit, into ſixteen *. Beyond this we cannot carry the powers of two in the diviſion of ſingle intervals. The diviſion into three equal parts is not ſo ſimple as that into two. By practice, however, it comes to be equally eaſy. Having eſtabliſhed this diviſion, we can, as in the former caſe, ſubdivide each of them into twos, into threes or into fours, thus obtaining a diviſion into ſix, nine and twelve. We alſo obtain the numbers ſix and twelve, by breaking down into threes each of the parts of a diviſion by two or four †. A diviſion into five equal parts requires a conſiderable effort of the attention. We ſometimes meet with a ſucceſſion of ſuch diviſions in the works of muſicians. In executing ſuch paſſages, the performer, fixing his attention upon the unit, probably runs on to the end of the ſucceſſion

* Eight is moſt eaſily conceived as two fours; ſixteen is always conceived as four fours.

† Six we can indifferently conceive as three twos or as two threes; nine we muſt conceive as three threes; twelve we can either conceive as three fours or four threes; we can alſo conceive it as two ſixes, but with more difficulty as ſix twos.

ſucceſſion as uniformly as he can, without greatly regarding the numbers. When we attempt the diviſion into five, we are often diſpoſed to break down the interval into two parts *, and ſubdivide the one part into three, and the other into two, making the two either equal to each other, or in the proportion of one and two. In the ſame manner, when we attempt the diviſion of an interval into ſeven, we are perhaps irreſiſtibly led to halve it, giving three to the one half and four to the other. A diviſion into any of the higher primes is impracticable.

We have not only the power of dividing and ſubdividing ſmall intervals or units of time in the manner I have explained, but we can alſo form aggregates of them, by telling off equal parcels of them, when they are rendered ſenſible to the ear by repeated ſtrokes or ſounds. We do this, by attending particularly to the firſt of each of the parcels. The conſequence of this is, that though the ſucceſſive ſtrokes give out exactly the ſame ſound, and are made with the ſame degree of force, we ſhall infallibly imagine the firſt of each of our parcels to be ſomewhat louder or more ſtrongly expreſſed than the others. When we have counted off one parcel, the mind conſiders the whole as one act; the parcel is as it were ſet by, and a new effort is made to count off the next parcel. Hence the firſt of this parcel, being marked by a particular effort of the mind, and as it were repreſenting the whole parcel, ſtrikes it more ſtrongly than the reſt, and is therefore conceived as louder; and the laſt of the parcel, being leaſt attended to by the mind, is conceived as feeble, thus giving us the impreſſion of ſomething like a break or pauſe betwixt the parcels. Thus, when we liſten to the beats of a watch, we are at firſt diſpoſed to reckon them by pairs; and we invariably find, that the firſt of each pair is conſidered by us as a ſtrong and the other as a feeble ſound.

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* More eſpecially if, in former parts of the ſucceſſion, the ſame interval has been found frequently divided into two.

We may be easily satisfied, however, that this is not always owing to any real inequality in the force of the sounds; because we can often reverse this order, by fixing the attention upon one of our feeble sounds, and considering it as the first of a parcel. After we have listened for some time to the beats, according to this new arrangement, we still find that the first of each pair is strong, and the other feeble. We can tell off the beats, not only by pairs, but also by parcels of three, four and other numbers; and in every case we uniformly imagine the first of each parcel to be more forcible than the others. We form these aggregates with greatest ease, according to the same proportions in which we make the divisions formerly described. We count off the successive equal intervals, marked by repeated sounds, most easily, by parcels of two and of four. When the single intervals are not large, we can also make parcels of eight. These arrangements give what the musicians call common time. We can also, with sufficient ease, reckon them by parcels of three and of six, thus obtaining what is called triple time. We can do more: we can even form aggregates of five equal intervals. We seem to do this by first telling off two pairs, then accounting the fifth a feeble sound, fixing the attention upon the sixth, and making that the first of the next two pairs, and so proceeding. We might, in the same manner, form aggregates of seven. As, however, by counting off three successive pairs, the mind has in a manner established the arrangement of strong and feeble sounds, it becomes greatly more difficult to consider the seventh as a feeble sound, and to fall into the new arrangement. Even when we reckon by parcels of five, we are desirous of having some little time to establish our new arrangement; and when the intervals marked by the successive sounds are perfectly equal, we always feel as if the sixth came upon us too soon; we wish that it might be suspended till the time of the third pair is completed. Aggregates of five occur frequently in poetry. They have sometimes,

times, we are told, been attempted alſo in modern muſic, but never with ſucceſs, and are now univerſally laid aſide *.

Besides the powers which we have of dividing and ſubdividing ſmall equal intervals or units of time, and of counting them off by equal ſucceſſive parcels, we have ſtill the farther power of combining together certain numbers of theſe parcels, or of feeling ſuch combinations, and conſidering them as ſomething ſeparate and diſtinct from what went before and what is to come after. We make theſe combinations by twos, by threes and by fours, rarely I believe by any other numbers. The parcels by which we firſt count off the intervals, are, in modern muſic, called *bars*, being marked in writing by perpendicular lines drawn acroſs the ſtave. Combinations of two, three or four of theſe bars are called muſical phraſes or ſtrains. The firſt note of every bar is accented †. In parcels of four, the third, being the firſt of a pair is alſo accented, but not ſo ſtrongly as the firſt.

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* The ancients defined certain meaſures, which they conſidered as aggregates of five and of ſeven, as meaſures of which rythmical ſucceſſions might be formed. Theſe they ſuppoſed to be made up of leſſer meaſures, bearing to one another, in the one caſe, the ſeſquialter proportion, or that of two to three, and in the other caſe the epitrite proportion, or that of three to four. Whether they had, or could have, a diſtinct feeling of theſe numbers, upon hearing a ſucceſſion of ſuch meaſures expreſſed in ſyllables, or whether ſuch a ſucceſſion could be expreſſed ſo as to communicate ſuch a feeling, are matters with regard to which I am much inclined to doubt. We may indeed conceive aggregates of five to be formed by counting off twos and threes, or threes and twos alternately; and, in like manner, aggregates of ſeven, by counting off threes and fours, or fours and threes. This, however, can hardly be done, unleſs the ſingle times are of ſuch magnitude, as that they may be conſidered as units of time, which is not the caſe with the ſhort ſyllables of words. Even when the ſingle times are ſufficiently large, the counting them off by alternate even and odd numbers, is a difficult, perhaps an unnatural operation. It requires ſuch a conſtant and even painful effort of the attention, as is inconſiſtent with that eaſe and ſimplicity of conception and operation, which is eſſential to every thing that is agreeable. If the attention is relaxed, we muſt either hold entirely by one number, or run into confuſion.

† I have here uſed the term *accent* in its muſical acceptation, to denote that imaginary degree of force or emphaſis which a ſound acquires from the circumſtance of its being the firſt of a parcel in a rythmical ſucceſſion.

This procefs of dividing and fubdividing, of compounding and fupercompounding fmall intervals or units of time, as I have now ftated it, appears, at firft view, to be extremely complicated. The whole, however, is undoubtedly gone through by every one who executes a piece of regular mufic in juft time, and by every one who hears a piece of mufic, and perceives the meafure of it; and this apparently without any labour or exertion of the mind. Perhaps the procefs, by which we perceive the relations in tone, which mufical founds bear to each other, is ftill more complicated, and yet this goes on even without our confcioufnefs.

When we hear a piece of mufic, we firft mark the fingle intervals or units of time; afterwards, from the fuperior degree of force with which the accented notes are expreffed, or from fome circumftances in the found or the rythm which draw the attention to thefe notes, we very quickly difcover, how many intervals are contained in each of the equal parcels, according to which the meafure is conftructed. Having eftablifhed this, we can with great eafe go along with the performer, and feel the proportional duration of every note. We are provided with a ftandard or fcale, to which we can refer the moft minute divifions that can be made, and by which we can meafure the longeft notes that may occur. If we are unacquainted with the piece, and do not at firft perceive the meafure, we are kept, during all that time, in a difagreeable ftate of fufpenfe, and are unable to liften with any degree of pleafure or fatisfaction.

The meafure is moft eafily perceived when the bars naturally combine into twos or fours, and when of thefe combinations the whole or each part of the piece contains a determinate even number. In this manner, the fimple popular airs, fuch as marches, gavots and minuets, are conftructed. There are very few who cannot eafily perceive and relifh the meafure in fuch airs. This regular ftructure, however, is not obferved

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in all muſic. In ſome pieces, the bars do not regularly combine into phraſes, or, if they do, the phraſes do not always contain the ſame number of bars. The number of the bars, too, is indeterminate, and ſometimes very great. In ſuch pieces, then, the meaſure muſt in general be formed of ſingle bars or parcels; and if the rythm is variegated by a conſiderable range of long and ſhort notes, and if the accented notes do not forcibly engage the attention, an unpractiſed hearer will ſometimes hardly perceive the meaſure at all. When this happens to be the caſe, it is impoſſible that he can receive any great pleaſure from that muſic. According to the language uſed upon ſuch occaſions, he does not underſtand it. Such difficult and perplexed meaſures, however, occur more rarely in the later compoſitions than in thoſe of the laſt century.

In ſuch meaſures, beating of time is of great uſe both to the performer and to the hearer. This ſeems to have been a practice ever ſince man had an idea of rythmical meaſures. We are naturally diſpoſed, upon hearing ſuch meaſures diſtinctly expreſſed, to accompany them with correſponding motions of the body; and hence probably the origin of dancing, to which exerciſe the term rythm has been frequently applied. The beating of time is performed by putting down the hand or foot, and giving a ſtroke at the inſtant in which the firſt note of every bar begins to be ſounded, and raiſing them up during the remaining time of the bar. This both directs the performer to execute the piece in uniform time, and enables the hearer readily to perceive the accented notes, and to aſcertain the meaſure. The ancients, in the performance of their muſic, and eſpecially of their dramatical muſic, where the band was numerous, beat time with great force and noiſe. This was perhaps neceſſary, as their meaſures were frequently unequal and irregular. The moderns, who generally conſtruct their muſic by equal and regular meaſures, have laid aſide that practice in every caſe where it is not indiſpenſable. We un-

doubtedly liſten with more ſatisfaction when we can perceive the meaſure from the real accent and expreſſion of the notes, than when we muſt be aſſiſted by the continual repetition of unmuſical ſounds.

SUCH then ſeem to be the nature, the extent and the manner of operation of what may be called our rythmical powers, or thoſe powers by which we aſcertain and perceive the proportional magnitudes of ſmall intervals of time, when theſe are marked out by motion, or by ſucceſſive ſounds. And from what has been ſaid, we eaſily ſee what a prodigious variety may be introduced into muſical rythm, from the great range of long and ſhort ſounds which may be occaſionally employed, and which may be diſpoſed and combined in a number of different ways almoſt infinite, without perplexing the hearer, or hindering him from readily and accurately feeling the proportional duration of each.

IN the foregoing account of theſe powers, I have frequently ſpoken of ſingle intervals or units of time. It may be proper, in this place, to explain a little more fully what I underſtood by theſe terms. It will readily occur to every one, that I did not mean to expreſs by them a certain invariable portion of abſolute duration. Theſe units, like units in all other ſubjects, are indeterminate and relative magnitudes. They mark ſometimes a greater, and at other times a leſs portion of abſolute duration. The ſame portion of abſolute time will, upon different occaſions, be conſidered as an unit, as a multiple and as a part. Every one, however, who has been converſant in muſic, experiences, that when he performs, or when he hears and goes along with a piece of muſic, there are certain notes which he uniformly conſiders as ſingle durations, of which all the longer notes that occur are aggregates, and the ſhorter notes are parts. He may therefore be very properly ſaid to have all this while the idea of an unity of time. Although theſe units of time differ conſiderably in their abſolute duration in different move-

ments,

ments, this difference is undoubtedly confined within certain limits. They can ſcarcely be much greater nor much leſs than the intervals marked by thoſe natural uniform motions from which our original impreſſions of rythmical movement are derived, and particularly the motion of our own limbs in walking or running. Perhaps the longeſt ſound which can be conſidered as a ſingle undivided duration, is hardly equal to the time of two ſeconds; and the ſhorteſt which can be eaſily counted without parcelling, is not much leſs than half a ſecond, or than the time in which we can diſtinctly pronounce the numeral names in ſucceſſion. We can indeed attend to the ſingle beats of a watch, but not without a conſiderable exertion of the mind; we reckon them much more eaſily by pairs or by fours.

It might here be aſked, what occaſion is there, in order to explain our perception of rythmical proportion, for ſuppoſing it neceſſary that the two oppoſite operations of diviſion and combination go on at the ſame time? Would it not be more ſimple and more natural to ſuppoſe, that the whole proceſs is carried on in the ſame direction, and by the ſame operation; and that either the longeſt ſound which occurs in the ſucceſſion is to be accounted the unit or ſtandard, and all the ſhorter ones formed and conceived as proportional diviſions of it; or elſe, that the ſhorteſt ſound is to be taken for the unit, and all the longer ſounds conceived as formed by combination? The anſwer is, that the proceſs of dividing and combining appears to be the proceſs of nature; and, for proof of this, appeal might be made to experience. When a perſon is inſtructed in muſic, he is taught to mark the time of a ſemibreve by four uniform motions of the hand. He is thus accuſtomed to conſider it, not as one time, but as four times, expreſſed, not ſeparately and diſtinctly, but in continuance; and I may venture to ſay, that the moſt experienced muſician does not conceive ſuch lengthened ſounds in a different manner. By practice and diſ-

cipline, indeed, he is enabled to give them a ſmooth and uniform intonation, without marking the ſingle times as they paſs, by a ſwell or more forcible expreſſion; but ſtill he is all the while reckoning thoſe ſingle times in his mind, or attending to the accompaniment by which they are for the moſt part diſtinctly articulated. Theſe lengthened ſounds, therefore, never are conceived as units or ſingle durations, but always as compounds. On the other hand, many ſounds occur in muſic which are too minute to be counted individually. Theſe, therefore, can only be conceived in groups, by being referred to ſome longer duration of which they are aliquot parts. This may be farther proved from the following circumſtance: In muſical ſucceſſions, we often find a duration which may be conſidered as an unit, divided at one time into fours, and at another time into threes or triplets. Theſe minute times, therefore, will be to one another in the proportion of three to four. If, therefore, it is thought practicable to account ſuch ſmall time the unit or ſtandard of a rythmical ſucceſſion, to which all the other times are to be referred, and by which they are to be eſtimated, I would aſk, which of the two minute times is to be taken for the unit, in the caſe above deſcribed? If the ſmalleſt is pitched upon, I would farther aſk, by what means are we enabled to expreſs the other accurately, in proportion to it as four to three, or to feel this proportion as ſubſiſting betwixt them, eſpecially as both are ſuppoſed to be incapable of further diviſion? The matter ſeems to be impoſſible. Such paſſages, however, are, by no means, conſidered as difficult or embarraſſing, even by young performers. Theſe ſmall times, therefore, are not conceived as units, but as diviſions, by the ſimple numbers four and three, of ſome longer duration, which has been often diſtinctly marked in the former parts of the piece, and with which the mind is familiar.

THESE

These opposite operations of division and combination facilitate and simplify the process of rythmical perception, and, at the same time, enable us to take in a much wider range of proportion, than could be done if we proceeded only in one direction. As the unit is commonly some intermediate time betwixt the longest and the shortest which occurs in the succession, it bears no very distant proportion to either of them. We frequently meet with semibreves and semiquavers in the same piece of music; notes which are to one another in the proportion of one to sixteen. This proportion is too great to be conceived and felt by a single operation of the mind. When, however, the crotchet is accounted the unit, we are enabled to estimate, and accurately to express, these distant times, without going beyond the simple and familiar proportion of four to one, on either hand.

The ancients indeed accounted their smallest time as the unit or standard of rythmical movement. This smallest time, however, was not less than that of a short syllable in pronunciation, and they had no sounds in their successions, which they considered as bearing to this a greater proportion than that of two to one. It may also be of importance to remark, that as their arithmetic was very imperfect, compared with that of the moderns, it is very probable that they had not the same ideas of fractional division, which we now have. In treating upon any subject, therefore, in which number is concerned, they would naturally take for their unit the smallest of the kind which they were examining, something that was either naturally indivisible, or that they did not expect to be under the necessity of dividing. Thus Aristides Quintilianus calls the single time of rythmical movement σημεῖον; a term by which, as he tells us, geometricians expressed that which has no parts. This time, he adds, being without parts, holds, in some degree, the place of unity *. The moderns, on the other hand, being able

* Page 32, 33. Edit. Meib.

able to conceive and expreſs proportional diviſions of the unit, with as much eaſe and accuracy as they do aggregate numbers, have it in their power to take their unit of ſuch dimenſion as beſt ſuits the nature of the ſubject. This circumſtance may perhaps enable us to account for ſome of thoſe differences which take place betwixt the opinions of the ancients and of the moderns, upon the ſubject of rythm.

THERE are a few remarks which it may be neceſſary to make, before I conclude this part of the ſubject.

IN muſic, we ſometimes find the unit of time divided into two unequal parts, in the proportion either of two to one, or of three to one. In making or perceiving this diviſion, we do not firſt break down the unit into three or four, and then allow two or three of theſe to the firſt note, and the remaining one to the other. We have not leiſure for this operation. We merely conceive the one as prolonged and accented, and the other as abrupt and feeble. Hence, when we hear ſuch diviſions, it is very difficult, without the aſſiſtance of the other parts of the meaſure, to determine whether they are made according to the one proportion or the other. A practiſed ear will frequently miſtake, and in writing muſic the one is ſometimes ſubſtituted for the other.

AFTER a diſtinct impreſſion has been obtained of the units of which a rythmical ſucceſſion is compoſed, and of the parcels according to which it is conſtructed, we do not loſe that impreſſion, although the ſucceſſion ſhould ſtop, or no ſound be heard, during the time of one or more of the units. Theſe vacant or ſilent times, if they are not too long continued, we reckon with nearly the ſame eaſe and certainty, as if they had all been expreſſed by ſounds ; and we clearly perceive the particular part of the meaſure at which the ſucceſſion of ſounds recommences. Theſe ſilent times are called *reſts* in muſic, and are always accounted as part of the meaſure. But this is not all. We can in a manner ſtop the courſe of the rythmical movement,

movement, or ſuſpend the flow of the units, during a time which is either indeterminate, or of which we take no exact account, and proceed afterwards as if no ſuch pauſe had been made. Theſe *ad libitum* pauſes, as they are called in muſic, are ſeldom taken into the meaſure, or conſidered as making any part of it. The intention of them is to rouſe and ſtrike the mind of the hearer; and there are various occaſions on which they may be introduced with very happy effect. Modern muſicians often uſe them as opportunities of diſplaying the extent of their invention and execution, when loſing ſight of the compoſer, giving the reins to their fancy, and little regarding rule or meaſure, they entertain their hearers with a ſeries of rapid diviſions through the whole compaſs of their inſtrument, and of uncommon and irregular modulations. But farther, we can not only ſuſpend for a time the courſe of the rythmical movement in the manner above deſcribed, we can alſo render it occaſionally ſlower or quicker, by increaſing or leſſening the dimenſion of the unit, when we wiſh to expreſs a heavy languid movement, or one that is light and animated; and after having executed a part of the ſucceſſion in that manner, we can often, with great accuracy, reſume our firſt unit, or return to our original time. We probably do this with moſt certainty, when this enlargement or diminution of the unit is made in ſome ſenſible proportion, as that of two to one. This practice, and the effects of it, were well known to the ancients. They made it a branch of their rythmical inſtitution, under the title of Αγωγὴ ῥυθμικὴ, or *Ductus Rythmicus*.

In muſic, the accented note, or beginning of the meaſure, is not always the firſt note that is ſounded; it is often preceded by one or more feeble notes, which are placed before the bar or perpendicular line which marks the commencement of the firſt meaſure. Theſe introductory notes are thought to give a ſoftneſs and delicacy to the opening of the piece. In regular muſic, when the parts are repeated, the time of theſe notes

is

is always compenſated at the concluſion of the ſtrain. The moſt graceful cloſe of a rythmical ſucceſſion is when the laſt ſound is long. We alſo reſt upon this ſound with moſt ſatisfaction when it begins upon an accented part of the meaſure. In this caſe, that meaſure may be left incomplete, by the exact quantity of the introductory note; ſo that when the ſtrain is repeated, this incomplete bar at the end, together with the introductory note at the beginning, make up one entire meaſure.

I NOW come to make ſome obſervations upon the rythm of poetry.

IT has already been remarked, that words being compoſed of ſyllables which differ in length according to certain proportions, are ſuſceptible of rythm. In all compoſitions, therefore, the object of which is to pleaſe and to affect, it has been the general practice to arrange the words in ſome agreeable rythm. One very common method for attaining this end has been, to form the words into parcels, according to certain meaſures and proportions; and in order that theſe parcels may be more readily perceived and attended to by the reader, to write them out in ſeparate lines.

THIS poetical rythm cannot poſſibly be ſo various and complicated as the muſical. The ſame principles, however, to a certain extent, take place in both. We find in poetry ſmall intervals or units of time regularly divided and combined. The diviſions, indeed, cannot poſſibly be ſo minute as they often are in muſic; neither are the parcels ſo equal and uniform. We have alſo in poetry accented and feeble ſounds; and verſes, like muſical ſtrains, are often introduced by one or more feeble ſounds, which ſometimes are compenſated at the end of the verſe, and at other times are not. In poetry, as in muſic, we often make up a part of the meaſure by reſts or ſilent times. In reciting verſes, too, we can make indefinite pauſes; and

and we are often inſenſibly led by the ſentiments or by the ſtructure of the words, to execute the *ductus rythmicus*, or occaſionally to accelerate or retard the movement.

In the ancient Greek and Latin languages, the proportion betwixt the long and the ſhort ſyllables is better aſcertained, more diſtinctly marked, and more ſenſibly felt, than it is in the modern languages of Europe. Thoſe languages are, therefore, ſuſceptible of a more perfect and a more diverſified rythm. The poets who have written in them have availed themſelves of this advantage, and have left us in their works a variety of very pleaſing rythmical meaſures. Critics have diſcovered the rules by which theſe meaſures were conſtructed; and, in order to explain them with greater eaſe, have eſtabliſhed and defined different ſmall ſcales of long and ſhort ſyllables, which have been called metrical feet, and by which the different meaſures have been parcelled out into their component parts. The names and the nature of theſe feet are generally known, and need not, in this place, be explained. I ſhall only, at this time, make two obſervations upon them. The firſt is, that they ſeem, in general, to mark what I have formerly called ſingle intervals or units of time, and theſe not very large. Any one may find, when he recites a verſe, that he can eaſily pronounce two feet in a ſecond; but that he can hardly draw them out, ſo as that each of them ſhall occupy the time of a ſecond. The other obſervation is, that it does not appear to have been the intention of the perſons who defined and applied theſe feet, to divide verſes by them always into equal intervals of time. The formation of them proceeds upon the ſuppoſition, that when a perſon recites a poem, he pronounces every ſhort ſyllable in one determined ſpace of time, and every long ſyllable in a ſpace of time exactly double of that in which he pronounces a ſhort one. The real duration, therefore, of any one foot will be to the real duration of any other foot exactly in proportion to the number of theſe ſmalleſt times contained

in each; and this can be accurately determined, by obſerving the number of long and ſhort ſyllables in each of them, and accounting every long ſyllable equivalent to two ſhort ones. In this manner we find, that the duration of an iambus or trochæus is to the duration of a ſpondæus or a dactylus exactly in the proportion of three to four. When theſe feet of unequal time, therefore, occur in the ſame verſe, which frequently happens in ſcanning, it is evident, that, upon this ſuppoſition, they do not divide that verſe according to equal intervals of time. Whether the ſuppoſition of this proportion, invariably ſubſiſting betwixt long and ſhort ſyllables, upon which this ſyſtem depends, be in every caſe well founded, may be the ſubject of future enquiry.

The units of time, of which the duration of verſes is made up, are ſometimes divided into twos and fours, and ſometimes into threes. Of the firſt we have an inſtance in the common hexameter verſe of the ancients. This is a regular rythm, the units being all equal, and formed into equal parcels. The number, of which the parcels conſiſt, is ſix. It may therefore be conſidered as a triple meaſure. In verſes, as well as in other rythmical ſucceſſions, the parcels of which conſiſt of any number greater than three, we are always diſpoſed to break down theſe parcels into the ſmaller numbers of which they are compoſed, or to conſider the whole parcel as an aggregate of theſe ſmaller parcels. This is the origin of what is called the pauſe or cæſural ſtop in verſes. As, according to what was formerly ſtated, the cloſe of a rythmical ſucceſſion, whether final or partial, is moſt agreeable, when the laſt ſound is long and accented, and as we are often diſpoſed to begin a ſucceſſion with one or more feeble ſounds; ſo, in making the diviſions of verſes, we reſt with moſt ſatisfaction upon a long ſyllable in an accented part of the meaſure, and begin the ſucceeding member moſt eaſily with a ſhort or feeble ſyllable, which we, in a manner, paſs over, and conſider as introductory to the

meaſure.

measure. The most simple division of six is into two threes. Hence we generally wish to conclude the first member of a hexameter verse with the first syllable of the third foot; and are pleased, when we have an opportunity of doing so, by that syllable being the termination of a word.

Tityre, tu patulæ — recubans sub tegmine fagi.
Nos patriæ fines — nos dulcia linquimus arva.

This division of the hexameter verse, not only gratifies the natural propensities above mentioned, but, as the concluding syllable of the verse is in the unaccented part of the measure, it gives a variety to the cadence of the two members, and prevents them from being similar or convertible *, which is always considered as a fault in the structure of verses, and undoubtedly gives them a disgusting uniformity. We can also make the break at the second syllable of the third foot, when it happens to be a dactyle; as, in this case, we have still a feeble sound with which to begin the second member, and the time of the first member is more nearly completed.

Formosam resonare — doces Amaryllida silvas.

This penthemimer division of the hexameter verse, though the most agreeable, does not always take place. To obtain variety, it is necessary that it should occasionally be divided otherwise. The number six may also be easily conceived as made up of three pairs. By making the break at the first syllable of the fourth foot, we have two pairs, deficient of their just time by the feeble syllable or syllables, which are introductory to the measure of the succeeding member.

Ille meas errare boves — ut cernis, et ipsum.

 The

* As, Cornua veletarum — vertimus antennarum.

The grammarians, led by the ſyſtem of half-feet, would not probably conſider the diviſion which I have made of the fifth line of VIRGIL's firſt Eclogue, quoted above, as the juſt one. They would rather ſuppoſe that the break took place at the end of the word *doces*. They would alſo ſuppoſe a ſubordinate diviſion at the word *formoſam*.

THE diviſion of the units into twos and fours, which takes place in the hexameter verſe, ſeems beſt ſuited to the ſtructure of the Latin and Greek languages. Pure trochaic or iambic verſes, where every alternate ſyllable is proſodically long, and the others are ſhort, occur but rarely in their works. Our language, again, ſeems ſcarcely to admit of ſuch diviſions. In our poetry, the ſyllables are arranged leſs according to their real quantity, than according to the accent* with which we are accuſtomed to pronounce them. An accented ſyllable has always the effect of a long one, and is qualified for being placed in the leading or accented part of a poetical meaſure. An unaccented ſyllable, on the other hand, gives us the impreſſion of a ſhort one, though by the common rules of proſody it ought to be long, and though it is, in reality, pronounced long. It is alſo diſqualified for being placed in the accented part of a meaſure. We have few inſtances of a real dactylus in ſingle words, though three ſhort ſyllables, from the accent with which the firſt is pronounced, often aſſumes the appearance of one. Engliſh verſes are conſtructed for the moſt part by feet of two ſyllables. The proportion which theſe two ſyllables bear to one another is ſeldom perceived with accuracy; neither is it of great importance that it ſhould be ſo perceived, provided the times of the entire feet, or of the two ſyllables taken together, be nearly equal. The impreſſion, however, which theſe feet, for

* WHEN I apply the term *accent* to ſyllables, I uſe it in its grammatical acceptation, to denote that ſuperior force of articulation, and that inflection of the voice, with which we always mark in our pronunciation ſome particular ſyllable or ſyllables of every word.

for the moſt part, communicate, is that of a trochæus or iambus. Our poets alſo conſtruct verſes ſometimes by feet of three ſyllables. Theſe feet, although the ſyllables of which they are compoſed are, for the moſt part, nearly equal, give us the impreſſion of ſomething like a dactylus or anapæſtus, according as the accented ſyllable is the firſt or the laſt of the three. In regard to their ſtructure, therefore, Engliſh verſes have been diſtinguiſhed into three kinds, trochaic, iambic and anapæſtic *.

Although all iambic verſes are to be conſidered as trochaics having a feeble ſyllable introductory to the meaſure, and ought always to be ſo ſcanned, yet the impreſſion which theſe two verſes make upon the ear, and the effects which they have upon the mind, are ſomewhat different. When we begin with the feeble ſound, we paſs eaſily and gently from it to the ſtrong ſound. We utter the ſtrong ſound without much exertion, and can dwell upon it for ſome time. On the contrary, when the ſtrong ſound comes firſt, we expreſs it with more difficulty and force, and paſs on to the ſucceeding feeble ſound with more rapidity. Hence trochaics have been generally reckoned ſomewhat quicker in their movement than iambics, and more proper for expreſſing vehemence or gaiety. As iambic verſes themſelves, however, have naturally a light and airy caſt, eſpecially when the combinations are made by even numbers, our beſt poets, to obviate this, have, in their more ſerious compoſitions, generally adopted a combination of five. This has accordingly been denominated the Engliſh heroic meaſure. The regular model of this verſe is as follows. The firſt ſyllable is unaccented, or ſhort and introductory to the meaſure. This is ſucceeded by four feet of two ſyllables, which, as the accent takes

* English trochaic and iambic verſes may be ſet to muſic in common or in triple time indifferently. Anapæſtic verſes require, for the moſt part, to be ſet in triple time. Shenston's Paſtoral Ballad ſet in common time, would loſe much of its beauty and delicacy.

takes place upon the firſt ſyllable, may be conſidered as trochees. After theſe, there is a ſtrong or accented ſyllable, which cloſes the verſe, and, along with the introductory ſyllable of the next line, completes the number of five feet *.

To | wake the | ſoul — by | tender | ſtrokes of | art.

This model is not always obſerved. Our beſt poets make frequent deviations from it, in order to give variety to the cadence of their verſes, or to render them more expreſſive of the ſentiments or emotions which they wiſh to convey.

THIS verſe, like the ancient hexameter, admits of a break or diviſion. As, according to what was formerly obſerved, we generally reckon combinations of five by two pairs and an odd one, we make this break with moſt ſatisfaction upon the leading ſound of the ſecond foot, or the fourth ſyllable of the verſe.

To make mankind — in conſcious virtue bold.

We can alſo make a diviſion at the ſixth ſyllable, as in this caſe we have ſtill one pair, with its introductory ſound, remaining.

Of that forbidden tree — whoſe mortal taſte †.

Sometimes too the words are ſo arranged, that the diviſion muſt neceſſarily take place at the fifth ſyllable or feeble ſound of the ſecond foot. This diviſion gives a pauſe more real, and more diſtinctly felt, than thoſe formerly mentioned. As we muſt begin

* THIS verſe is a combination of five times, more in appearance than in reality. When it is well conſtructed, it will ſeldom fail to give the perſon who pronounces it the diſpoſition and opportunity, by means of reſts, of completing ſix, ſometimes perhaps eight times.

† WHEN, by means of reſts at the cloſe, the time of ſix feet is completed in pronunciation, this break divides the whole time into two threes.

gin the ſecond member with a ſtrong ſound, and are partly deprived of the aſſiſtance in forming it, which we would have derived from the preceding feeble ſound, we require a little more time to make the exertion which is neceſſary for that purpoſe. This diviſion alſo changes, in ſome degree, the character of the verſe, the laſt member becoming proper trochaic. It may ſometimes, however, be uſed with a very happy effect. There ſeems to be an inſtance of this in the firſt line of POPE's Eſſay on Man.

A|wake, my | St JOHN. | — Leave all | meaner | things,

Here the grammatical pauſe, coinciding with the rythmical diviſion, gives ſufficient time to form the accented ſound with which the ſecond member begins; and that member being trochaic, is very well ſuited to expreſs the intention of the poet, which is to rouſe. The ſame diviſion occurs in the ſecond line; but the effect of it is ſomewhat different.

To low ambition — and the pride of kings.

In reciting this line, we are unwilling to give an accent to the conjunctive particle *and*. To avoid this, therefore, we are diſpoſed to conſider both that word, and the article which follows it, as feeble ſounds, introductory to the next ſtrong ſound, and to fill up the time of the accented part of that third meaſure by a ſilence or reſt.

To | low am|bition — | ſ and the | pride of | kings.

In this way, the reciter, hurrying over theſe two comparatively unimportant words, almoſt in the time of one feeble ſyllable, is naturally led to expreſs the word *pride* with conſiderable force or emphaſis; a circumſtance which ſeems, in this place, to favour

vour the deſign of the poet. Verſes of this form occur frequently in the works of this author.

The ſtructure of the Engliſh heroic verſe, and the uneven number of feet of which it is compoſed, effectually ſecures it againſt the danger, or even the poſſibility of its being divided into two parts which are equal, and at the ſame time ſimilar and convertible. When the break takes place at an accented or ſtrong ſyllable, the two members are neceſſarily unequal. When, again, as in the two lines laſt quoted, the diviſion happens at the fifth ſyllable, the two members, though they may be equal in time, are neceſſarily different in cadence, as the firſt begins and ends with a feeble ſound, and the ſecond regularly begins and ends with a ſtrong ſound. This ſeems to give to the Engliſh verſe of this form a conſiderable advantage over the common French verſe of ſix feet, which uniformly divides into equal and ſimilar hemiſticks.

These breaks or diviſions in verſes have perhaps been improperly termed pauſes. In many caſes, the pauſe is more imaginary than real. I have formerly obſerved, that we have always, in a greater or leſs degree, the impreſſion of a pauſe betwixt every parcel of equal times which we form. When we hear a minuet, or any piece of muſic, which is conſtructed according to regular rythm, we have the impreſſion of a pauſe at the end of every bar; we have the ſame impreſſion more ſtrongly at the end of every phraſe; and yet we are certain, that, at many of thoſe paſſages, no real pauſe is made. It frequently happens, that the proper break or rythmical diviſion of a verſe takes place at one part of it, when the reſt, the grammatical ſtop, or the pauſe of ſuſpenſion, occurs at another part of it.

And | leaves the | world — to | darkneſs | ſ and to | me.

In this line, the rythmical diviſion takes place at the fourth ſyllable, where little or no real pauſe is neceſſary. From what was

was above obſerved, however, upon the ſtructure of the ſecond line of POPE's Eſſay on Man, there muſt be a ſenſible reſt or ſilence betwixt the ſeventh and eighth ſyllables. Accordingly, this has commonly been conſidered, and perhaps with propriety, as the place of the pauſe in this line. It is probable, however, that the cadence of the verſe would not have been ſo agreeable and ſatisfactory, if the regular rythmical diviſion had not occurred at the fourth ſyllable.

SOME additional obſervations upon rythmical meaſures, and upon the ſtructure of ancient and modern verſes, ſhall be reſerved to the ſecond part of this Eſſay.

PART II.

IN the former part of this Eſſay, I endeavoured to eſtabliſh the general foundations of rythm, and to explain the nature and the extent of thoſe powers, by which we perceive the proportional magnitudes of ſmall intervals of time, when theſe are made obvious to the ſenſes by motion or by ſucceſſive ſounds. The caſe of ſounds being that which is moſt intereſting, I directed my attention chiefly to it. Rythm in ſound I diſtinguiſhed into three kinds, muſical, poetical and proſaic; and made ſome obſervations upon the two firſt of theſe. I propoſe, in this part, to offer a few obſervations relative to the ſame ſubjects, which may tend to throw ſome further light upon them. In theſe obſervations, I ſhall have the following objects chiefly in view: To explain that ſtructure or arrangement of meaſured ſounds, which may be ſaid to give a regular and perfect rythm; to mark the gradual deviations from that regular ſtructure, which appear in thoſe productions of human genius which are

intended to pleaſe, and of which the agreeable effect depends, in any degree, upon rythm; and, laſtly, to apply the principles which may be delivered, to illuſtrate ſome particulars in the ſtructure of verſes.

In entering upon the firſt of theſe, it will be proper to recapitulate ſhortly the account which I formerly gave of what may be called our rythmical powers.

From our conſtitution, or from our habits, we have the power of marking and perceiving equal intervals of time, when thoſe intervals do not exceed a certain magnitude. When we fix our attention upon one of thoſe intervals, and conſider it as an unit of time, we can ſuppoſe it to be divided into a certain number of equal parts, and by motion we actually can make ſuch a diviſion. The number of parts into which we can thus divide a given interval, muſt neceſſarily depend upon the powers which we have of performing quick motions. It is, however, regulated alſo by the preference which the mind naturally gives to the ſimpler numbers. We divide with greateſt eaſe by two and its powers. We can alſo, with ſufficient eaſe, divide by three, nine, and the ſmaller compounds of two and three. To make an equable diviſion into five is difficult, into ſeven is perhaps impracticable, and into any of the higher primes is certainly ſo. Again, when we hear a number of equal intervals of time diſtinctly marked by ſucceſſive ſounds, we are always diſpoſed to count them off by equal numbers, thus forming them into ſets or parcels. In doing this, as in making diviſions, we always prefer the ſimpleſt numbers. When, therefore, there is nothing in the nature of the ſounds to determine our choice, we uſually count off the intervals by pairs, by fours or by eights. We can alſo, with ſufficient eaſe, count them off by threes and by ſixes. As the firſt ſound of each parcel is marked by a particular effort of the mind, and conſidered by it as repreſenting the whole parcel, it is conceived to be more forcible than the other ſounds of that parcel, which, being leſs

attended

attended to by the mind, are conceived as feeble. As five is too large a number to be comprehended by one individual act of the mind, we can only form parcels of that number, by counting off two pairs, considering the fifth single sound as feeble, and fixing our attention upon the sixth, as the leading sound of the next pair; or by counting off twos and threes, or threes and twos alternately. This insertion of the single time, at the end of every two pairs, changes the order of the strong and feeble sounds, in every succeeding parcel. Although this operation is practicable, it is probably very seldom actually performed. The frequent and sudden changes of the arrangement of strong and feeble sounds, require an uneasy effort of attention in the performer, and give an unpleasing surprise and disappointment to the hearer. Both feel a strong desire to have the number of six times completed, either by a lengthened sound, or by a silence. Lastly, we have the farther power and disposition to join together two, three or four of our first parcels, thus forming larger combinations.

By means then of the powers now described, we are enabled to express a succession of sounds whose durations may be very different, but may, at the same time, be most accurately related to one another, according to certain proportions. We are also enabled, upon hearing such a succession of sounds, with readiness and ease, to feel the proportional duration of each, provided the simple proportions above mentioned be constantly observed. In order to this, we first of all fix our attention upon some determined duration, which may be something near to the intervals observed in walking, or in some other of the uniform motions with which we are familiar. This duration we consider as an unit of time. Having established this, we can express any number of them with great uniformity; we can divide some of them as we go along into parts, or combine two or more of them into lengthened sounds. By habit, we can take our unit, at different times, greater or smaller; we can

make larger combinations, and more minute and diverſified diviſions. We go through a ſimilar proceſs, when we liſten to ſuch a ſucceſſion of ſounds, and perceive their proportional durations. As the exerciſe of every power, which we poſſeſs, conveys a certain degree of pleaſure, we obtain a gratification, when we hear a ſucceſſion of ſounds juſtly proportioned in duration to one another, and are able, at the ſame time, to go along with, or to feel the ſeveral proportions which they bear. This then is undoubtedly one foundation of the ſatisfaction which we derive from every kind of rythm. It can be no juſt objection to this, that we frequently are not conſcious, upon hearing a ſucceſſion of rythmical ſounds, of perceiving the various proportions which they bear to one another. Our being pleaſed with the proportions, our acquieſcing in them, is a ſure indication that we feel them. If the unit were varied, or if diviſions were attempted, to which we have not been accuſtomed, and with which we cannot go along, we ſhould inſtantly feel the difference. Our pleaſure would be ſenſibly diminiſhed or altogether deſtroyed.

To form then a regular and agreeable rythm, it is neceſſary that all the units in ſucceſſion be equal intervals of time, and that their diviſions be ſimple and obvious. This, however, is not all. I have already obſerved, that when we hear ſuch a ſucceſſion of intervals, we are always diſpoſed to form them into equal parcels. As, however, there ſeems to be nothing to lead us to count off theſe parcels by any one number in preference to another, and as we can do it by a few of the ſmaller and ſimpler numbers with almoſt equal eaſe, we naturally wiſh to have ſomething that may determine our choice. If we are not led eaſily and readily to one particular number, or if, after we have fixed upon a number, we find ourſelves obliged to give it up, and to adopt another number, we are uneaſy and diſſatisfied. For this reaſon, a rythm that may be perfectly agreeable and ſatisfactory, muſt be conſtructed according to ſome meaſure;

ſure; the whole ſucceſſion muſt be made up of parcels of ſome determined number of units, and muſt be ſo contrived as that the hearer may be inſtantly led to adopt that number, and retain it to the end of the ſucceſſion. This may be effected by various means. If, for inſtance, we wiſh that the hearer ſhould count off the equal times by parcels of four, we may firſt expreſs four diſtinct and undivided units, and afterwards other four in ſome way combined or divided *. By this means, the hearer will naturally be led, after having reckoned four units, to ſtop and begin a new parcel. He will be ſtill more confirmed in this arrangement, if we make our third parcel ſimilar to the firſt, and our fourth ſimilar to the ſecond †. We may obtain the ſame end, by expreſſing three diſtinct undivided units, and reſting during the time of the fourth, and ſtill more certainly by doing the ſame thing over again. In like manner parcels of other numbers may be ſuggeſted. Various other contrivances for indicating the meaſure, will readily occur to every one who attends to the works of muſicians. The return of ſimilar ſounds, and of ſimilar combinations and diviſions, after any number of units has been expreſſed, naturally fixes the attention of the hearer to that number, and determines him to adopt it, for counting off ſucceeding parcels; and if care be taken not to confound him, by bringing in ſuch returns at different parts of the parcel, by continuing ſounds from the end of one parcel to the beginning of the next, or by making minute and perplexed diviſions, he will hold by that number to the end of the piece.

We naturally wiſh, when hearing a ſucceſſion of meaſured ſounds, not only to form them into parcels, but alſo to join two, three or four of thoſe parcels together, thus forming larger

* Firſt movement of the ſixth periodical overture, publiſhed by R. Bremner.

† Symphony to the firſt recitative in Handel's Messiah.

larger combinations or ſtrains. We may be aſſiſted in doing this, and determined to a particular number, by the ſame means by which we are aſſiſted and determined in forming the ſingle parcels, chiefly by pauſes, and by the return of ſimilar ſounds, or of ſimilar combinations and diviſions. By being led to form ſuch aggregates, the pleaſure we derive from liſtening to the ſucceſſion is greatly increaſed. We are thus provided with certain ſtages or reſting-places, and are enabled to count off the parcels with more ſteadineſs, and with a ſmaller effort of the attention. Our ſatisfaction is ſtill farther enhanced, when the entire piece conſiſts of ſome ſimple and agreeable number of ſuch aggregates. We have then the impreſſion of a whole, of ſomething finiſhed and complete; and have a lively perception of that proportion and arrangement of parts, which is eſſential to every thing that can be accounted beautiful or pleaſing.

We may now be able to form ſome preciſe idea of what may be called a regular and perfect rythm. It is a ſucceſſion of meaſured ſounds, all of which are either equal to, or are certain multiples or certain parts of ſome determined portion of time, which may be called an unit, and are ſo arranged and diſpoſed that the hearer is eaſily led to count off thoſe units by equal parcels of ſome ſimple number, and alſo to combine two, three or four of thoſe parcels together, the whole ſucceſſion containing a ſmall determined number of thoſe larger aggregates. It is in this manner, that all thoſe pieces of muſic, which are commonly called *airs*, are conſtructed. The regular minuet conſiſts of two parts or complete ſtrains, the units are conſtantly formed into parcels of three, and each part contains eight of thoſe parcels or bars, which the hearer is diſpoſed to combine into aggregates of two or four. The regular march and gavot are conſtructed in the ſame manner, only the bars or firſt parcels conſiſt of four units in place of three.

Having

Having eſtabliſhed this ſtructure as the ſtandard of regular and perfect rythm, I proceed to mark the gradual deviations from it that appear in thoſe productions of human genius which are intended to pleaſe, and of which the agreeable effect depends in any degree upon rythm. The artiſts who have been employed in ſuch productions, ſeem to have had two objects chiefly in view in occaſionally departing from this regular ſtructure, namely, to introduce variety into their works, and to render them more expreſſive of certain feelings and emotions of the mind. I can only at this time conſider the firſt of theſe.

In all thoſe works which are addreſſed to the fancy, that which is moſt ſimple and moſt eaſily conceived, is always that which firſt of all engages the attention and communicates pleaſure. While our powers of perception are yet in their infancy, it is impoſſible that we can go along with what is various and complicated. Nothing but what is diſtinctly felt can communicate real pleaſure. We may perhaps not always be able to analyze our feeling, and may therefore ſay that we are pleaſed we know not why. When it is analyzed, however, it will be generally found to have been a diſtinct feeling, or in other words, the objects which excited it will be found to have been commenſurate to our powers of perception. As we ſeem to derive our firſt ideas of ſmall equal intervals of time, from the uniform motion of our own limbs, or of thoſe of other animals in walking, we probably from the ſame ſource acquire the habit of counting off ſuch intervals by pairs. When, from any circumſtance, the firſt of each alternate pair is made particularly to attract the attention, we are then diſpoſed to join two pairs together, to form parcels of four, or to conſider each four as ſomething ſeparate and diſtinct from what went before and what is to come after. We may, in the ſame manner, be led to join two or four of theſe parcels together, in order to obtain what we may account a whole. Gradually we are enabled to conceive

conceive a ſingle interval to be halved, and each half to be again ſubdivided in the ſame proportion. We thus obtain the ſpondæus, dactylus and double pyrrichius. It would appear, then, that ſomething of the nature of the march or gavot meaſure above deſcribed, gives the moſt ſimple and eaſy rythm, and is that which would probably firſt of all ſtrike and pleaſe the human mind. Dr BURNEY, in his account of CROTCH, the muſical child, publiſhed in the Philoſophical Tranſactions, remarks of him, that, when he plays from his own fancy, what rythm he obſerves is generally of the march kind, proceeding chiefly by the dactylus and ſpondæus. The firſt verſes of the ancients were probably formed of the ſame meaſures.

As mens powers of perception improve, they naturally wiſh for objects ſuited to them. That which is moſt ſimple, and was at firſt moſt agreeable, gradually loſes its charm; they wiſh for ſomething that may give more employment to their powers. They could not, therefore, be always confined to the uniform movement by pairs and double pairs, but would endeavour in ſome way to diverſify it. Their firſt contrivance for this purpoſe might poſſibly be, to depart occaſionally from the original arrangement of two, four, eight, by throwing in an additional pair to their two, or two additional pairs to their four, thus making combinations of three or of ſix pairs. The dactylus and ſpondæus at the end of the common hexameter verſe, may thus poſſibly have been an addition to the verſes of four feet, which had formerly been uſed, and might then have been conſidered as an improvement. After combinations of three pairs had become familiar, it was an eaſy ſtep from that to arrange by parcels of three units; and thus the ſimple triple time was obtained. This, though ſtill farther removed from the original meaſure, became probably on that account the more pleaſing. It gave more exerciſe to the rythmical powers; at the ſame time, it did not fatigue them. It was free from the ſolemnity and uniformity of regular pairs. The minuet accordingly ever has

has been, and is at this day accounted the moſt elegant and pleaſing movement in muſic. This meaſure is almoſt entirely confined to muſic. There is ſcarcely an inſtance of verſes, which are conſtructed exactly according to it, unleſs perhaps the Ionian verſe of the ancients, a verſe which does not often occur in their works, and which, from the heavy uniformity of its movement, is by no means pleaſing *. From parcelling by threes, it was an eaſy tranſition to divide the unit by the ſame number. For this, nothing more was required, than gradually to diminiſh the unit, and to take the parcels of three by pairs: each parcel would come at laſt to be conſidered as a ſingle unit divided. They would thus form the tribrachys, trochæus and iambus, according as they expreſſed each of the three parts ſeparately, or joined any two of them together. In this way would be obtained the gig meaſure in muſic, and the trochaic and iambic verſes in poetry †. Such parcels and diviſions by three would probably at firſt be formed into ſtrains or larger combinations, by twos and fours; and this is ſtill the moſt uſual arrangement. In proceſs of time, however, they would alſo be formed by threes and ſixes. Thus the trimeter or ſenarian iambic verſe might be derived from the dimeter, or verſe of four ſingle feet.

So long as the bars or firſt parcels, whether of pairs or threes, are equal, the larger combinations uniformly contain the ſame number of bars, and theſe laſt are reſtricted to ſome ſimple and obvious number, the rythm may be conſidered as regular. The moſt gentle deviation from this ſtructure, if in truth it can be called ſuch, is extending the entire piece beyond

 the

* THERE is only one ode of HORACE in this meaſure, *viz.* Book III. Ode 12. The rythm ſeems to go on to the end, without any ſenſible break or cloſe.

† THE tribrachys, or gig meaſure, may poſſibly have been ſuggeſted immediately from the ſound of a horſe's feet, when running at full ſpeed.

the limits above aſſigned. The modern muſicians frequently compoſe pieces of conſiderable length, and conſiſting of a number of bars too great for the mind to keep an exact regiſter or account of them. This enables them to take a wider range of melody and modulation, than they could do if their pieces were confined within the limits of ſhort regular air, and to prolong and diverſify the pleaſure of the hearer. If in ſuch extended pieces, however, the bars uniformly aſſemble into equal groups or combinations, and if the whole piece, and each larger diviſion of it, contain an even number of ſuch combinations, the hearer has ſtill the impreſſion of a juſtly proportioned whole; and even within this limitation a very copious variety may be obtained. Men, however, could not always bear this confinement. In proportion as rythmical meaſures become more an object of attention, and are more frequently preſented to the ear, the neceſſity of variety becomes the greater. The moſt agreeable meaſures, when too often repeated, become diſguſting. We are often pleaſed with a bold deviation from what is ſtrictly regular. The very ſurpriſe which it cauſes is agreeable. It ſeems to have been in part from this principle, that the compoſers of muſic have occaſionally departed from the regular ſtructure of rythm.

The leaſt offenſive deviation, which can be made from that ſtructure, is the departing at times from the uniform equality of the ſtrains or larger combinations. It is eſſential to the minuet that the bars conſtantly proceed by pairs. In the regular minuet, there is always a more diſtinct cadence at the end of every ſecond pair. By this means, the hearer is led to join two pairs together, or to make combinations of four bars. This arrangement is neceſſary to render the rythm of the muſic ſtrictly conformable to the movement of the dance, which it is intended to regulate. The whole piece commonly contains four of thoſe larger combinations, two of which go to the firſt part or complete ſtrain, and two to the ſecond. In order, however, to give more

more variety and extent to the compoſition, a part may be made to conſiſt of three, four or ſix of thoſe combinations; or, by occaſionally adding two bars, combinations of ſix may be formed. All this may be done, without loſing the diſtinguiſhing characteriſtic of the minuet. But if either the rythm is ſo contrived, or the muſical cadences are ſo placed, as at any time to form combinations of three or of five bars, the piece then ceaſes to be a minuet. It may, however, notwithſtanding this, be a pleaſing compoſition. The modern muſicians, eſpecially thoſe of the German ſchool, often ſubjoin to the minuets of their inſtrumental pieces, airs of the ſame time and meaſure, which they ſometimes call ſecond minuets, but more frequently trios. In compoſing theſe trios, they ſometimes take an opportunity of diſplaying their learning and invention, and of ſearching for novelty, without conſidering themſelves as under obligation to adhere to the elegant ſimplicity of ſtyle, or the regular rythmical ſtructure of the minuet. By this means, the hearer is for a while very agreeably entertained, and the beauty and peculiar qualities of the minuet, which is always repeated after the trio, are rendered more ſtriking. In theſe airs, combinations of three bars are frequently to be found *. As, however, two of theſe combinations often occur in ſucceſſion, and the other parts of the piece proceed commonly by pairs, the number of bars in the complete ſtrain or air is in moſt caſes even, or diviſible by two.

In pieces of conſiderable extent, ſuch licences, when uſed with moderation, frequently paſs without being greatly obſerved. They may even at times produce a very happy effect. They ſerve to rouſe the attention of the hearer, which is apt to flag in a long piece, when the rythm uniformly proceeds by equal combinations; and they often give a more emphatic in-

 troduction,

* Trio of firſt minuet in third quartetto of Haydn, firſt ſet. Trio of ſecond minuet in ſecond quartetto of the ſame author, ſecond ſet.

troduction, or a more ſtriking and diſtinct cloſe, to ſome remarkable ſtrain. In ſuch pieces, the bars very frequently proceed by pairs. It is no unuſual thing, however, for the compoſer, in the courſe of the piece, to invert the order of the pairs, or to conſtruct the muſic in ſuch a manner, as to lead the hearer occaſionally to conſider thoſe bars as the firſt or leading bars of a pair, which, from the place in which they ſtand in the piece, ought to be accounted the ſecond or following. This is done in various ways. When a ſtrain, for inſtance, happens to cloſe upon the beginning of an odd bar, in place of completing the time of the even bar which ſhould follow it, by ſound or ſilence, that ſtrain is either immediately repeated, or a new ſtrain is introduced *. When, again, a ſtrain concludes upon the firſt of an even bar, the key-note, or one of its harmonics, with which that bar begins, is ſometimes made the commencement of a new ſtrain, and of courſe to ſtand as the leading bar of the next pair †. This is very often practiſed by the compoſers of inſtrumental ſymphonies, when it is intended by them, that the paſſage thus brought in ſhould be ſenſibly different in loudneſs or in ſtyle from what went before. A bold and animated ſtrain eſpecially, in which all the inſtruments join and exert their whole power, is thought to produce a greater effect, when it is introduced in this ſudden and abrupt manner. The arrangement of the pairs is alſo ſometimes inverted, by the repetition of a bar in the middle of a ſtrain. Such repetitions ſeem, upon ſome occaſions, to give the appearance of greater buſtle and confuſion to muſic that is impetuous and rapid ‡. Laſtly, the firſt bar of a movement, or of ſome particular

* Eleventh periodical overture, laſt movement, at the thirty-firſt bar.

† The ſame movement at the forty-ſeventh bar, where the original arrangement of the pairs is reſtored.

‡ Third quartetto by Haydn, firſt ſet, laſt movement, at the 15th bar of the firſt part, and the 29th bar of the ſecond part.

cular ſtrain in the progreſs of it, is ſometimes occupied by the key-note, ſtruck with emphaſis, and followed by one or more feeble notes, introductory to the next meaſure. This firſt bar being as it were ſet aſide, or conſidered as ſtanding by itſelf, the muſic afterwards proceeds by regular pairs, commencing at the ſecond bar *. When inverſions occur at the end of three or of five bars, diſtinct combinations of theſe numbers are formed †. Such ſmaller uneven combinations are very often repeated, and thus the original arrangement is reſtored. In other caſes too, when by any means the firſt arrangement of the pairs or double bars has been inverted, it is frequently reſtored either by the ſame or by ſome other means. Sometimes, however, the altered arrangement continues to the end of the piece, and the number of bars in it becomes thereby uneven. As pleaſure is often heightened by variety and contraſt, ſuch occaſional interruptions of uniform movement give an additional reliſh to the regularity that is obſerved in other parts of the compoſition. Their effect is ſomewhat analogous to that of diſcords in the harmonical ſtructure of muſic.

The licences with reſpect to the combinations of the bars, which have been mentioned above, though they ſeldom fail to ſtrike a perſon who has a good ear, do not prevent the rythm from being diſtinct and pleaſing. In ſome muſical compoſitions, however, ſuch licences are carried to a greater extent. The combinations are ſometimes ſo various and obſcure, that the hearer can ſcarcely retain the impreſſion of them. This is often the caſe in the longer and more grave and ſolemn pieces of what is now, by way of diſtinction, called the ancient muſic,

* First quartetto of the ſame ſet, laſt movement, at the beginning, and firſt movement, at the 23d bar of the firſt part, and correſponding paſſage of the ſecond part.

† The firſt quartetto of Haydn's ſecond ſet begins with two combinations of three bars, after which the muſic proceeds in general by pairs. The ſecond part of the laſt movement of the firſt of ſix overtures by the Earl of Kelly, begins with two ſucceſſive combinations of five bars.

ſic, and particularly in that ſpecies of it, which is known by the name of the fugue. This had its riſe at the time when the chief profeſſors and improvers of the muſical art were churchmen, and when, of courſe, that kind of muſic was chiefly cultivated, which was thought to be beſt calculated to compoſe and elevate the mind, and to inſpire devotion. A ſimple, regular and diſtinct rythm was probably thought by them to give the muſic a light and airy caſt, inconſiſtent with the effect which they wiſhed to produce. They either made the movement ſlow and the notes equal, in which caſe the attention of the hearer was almoſt wholly directed to the tone and modulation; or if, in their inſtrumental muſic, they introduced a quicker and more varied movement, they ſtudiouſly avoided every thing, which might have the appearance of regular air. The fugue ſeems to be well calculated to anſwer this intention. It is executed by two, three or more voices or inſtruments in concert. All of them in ſucceſſion are made to ſound ſome ſhort ſimple melody, which is called the ſubject. This is frequently repeated or imitated by them, in a variety of different keys, the repetitions coming in at unequal intervals, and often in the middle of a bar. As the compoſition of the fugue was thought to be a great diſplay of art and ſkill, it was afterwards introduced into every kind of inſtrumental muſic, and was gradually rendered more complicated. As the rythmical combinations are often irregular and indiſtinctly marked, and the harmonical parts are frequently running counter to one another, it requires great attention to perform it with preciſion and accuracy, and of all muſic it gives leaſt pleaſure to one who has not been accuſtomed to it. The taſte for this kind of muſic has been for ſome time declining, and it is now moſtly confined to the church.

Almost every degree of irregularity, then, in the combinations of the bars may be occaſionally tolerated. This, however, is by no means the caſe with the bars themſelves, or the ſingle

ſingle parcels. Any inequality among them is more ſenſibly felt, and when improperly introduced, never fails to hurt and diſpleaſe. Such inequalities may be made, either by increaſing or diminiſhing the unit, thus making the movement quicker or ſlower, or by varying the meaſure, or the number, according to which the bars are formed. In a long piece of muſic, a conſiderable variety, both of movement and of meaſure, may be introduced. Changes, however, are ſeldom made, until the movement has gone on for ſome time, in one uniform movement and meaſure, and has been brought to a cloſe more or leſs complete. Such changes, when ſkilfully managed, enliven the muſic, ſurpriſe the hearer, and excite his attention. When, however, they occur very often, and at ſmall intervals, they never fail to perplex and confound. The hearer is kept in a ſtate of continual ſuſpenſe and uncertainty, and therefore cannot liſten with ſatisfaction. The French muſicians, rather perhaps in conſequence of ſome fanciful theories, than from the ſuggeſtions of good taſte, or the experience of agreeable effect, have ſometimes introduced frequent and ſudden changes of movement and meaſure into their pieces. Their example, however, has not been much followed. How often, or at how ſmall intervals, changes of meaſure may be introduced into a muſical compoſition, is a matter that is difficult to determine. It muſt depend a good deal upon the taſte of men, and upon the habits which they may have formed. There is certainly, however, ſome limit, within which ſuch changes cannot be made, without giving more uneaſineſs than ſatisfaction to the hearer. We may bear to be, in ſome degree, offended a certain number of times, when ſuch offence has the effect to ſtimulate and ſurpriſe, and when it is quickly compenſated by ſome ſtriking beauty; but if the experiment is too often repeated, the end propoſed will be defeated. The piece will become a motely aſſemblage of diſſimilar and unconnected parts, and

will

will communicate no ſentiment but that of ridicule or of diſguſt.

To change the meaſure or the number of equal times in a bar, in the courſe of a ſhort ſtrain or rythmical clauſe, has, ſo far as I know, never been attempted by a modern muſician, and probably would not be tolerated. And yet, if we are to believe the accounts, which have been tranſmitted to us by ancient authors, this practice was not unfrequent amongſt the muſicians of Greece. The verſes, to which they adapted muſic, were often compoſed of unequal feet, ſuch as trochees and ſpondees, which they reſpectively conſidered as meaſures of three and of four equal times, and theſe occurring ſometimes alternately; and we are told that the muſic rigidly obſerved the meaſure of the verſes. If this was indeed the caſe, it is a ſingular fact in the hiſtory of muſic, to which perhaps no parallel has been found. After the many clear and expreſs teſtimonies to the truth of that fact, which have been given by enlightened authors, who were natives of the country, and who may be ſuppoſed to have been well acquainted with, and to have had frequent opportunities of hearing that muſic, it may appear highly preſumptuous to expreſs the ſmalleſt doubt with regard to it. There are, however, ſome conſiderations which ſtrongly incline me to indulge at leaſt ſome degree of ſcepticiſm, and to ſuppoſe that nature, perhaps without their conſciouſneſs, might at times prevail over ſyſtem.

I FORMERLY obſerved, that to count off alternate parcels of two and of three equal times, and thereby to form aggregates of five, is by no means impracticable; but that it requires an uneaſy effort of the attention, and that both the performer and the hearer feel a ſtrong deſire to have the even number of ſix times completed, either by a lengthened ſound, or by a ſilence. I may here add, that neither is it impracticable to form alternate parcels of three and of four times, but that, as the number ſeven, the aggregate of theſe, is leſs agreeable and ſatiſfactory,

factory, and lefs eafily comprehended than five, and as it is nearer in proportion to eight than five is to fix; the defire of completing, by fome means or other, the number of eight times will be ftill ftronger, and will not be refifted without a great and conftant effort of the attention, and even fome degree of force and conftraint. The difficulty will be much increafed, if the unequal meafures do not occur periodically in regular fucceffion, but are varioufly introduced in the courfe of different ftrains, without any fixed or permanent rule. In order that fuch unequal meafures may be expreffed with accuracy, it feems neceffary, that the equal times of which they are compofed, fhould be of fuch dimenfion as that they may be counted fingle. If they are too minute to be fo counted, it will probably be impoffible for the performer to mark with certainty, or for the hearer to perceive diftinctly, the proportion which fubfifts betwixt the contiguous unequal bars; as there is no common meafure or ftandard to which they may be referred, or by which they may be adjufted. It feems neceffary, moreover, not only that the beginning of every meafure fhould be diftinctly marked, but alfo that every fingle interval of time fhould be rendered obvious, either to the eye or to the ear of the performer. Unlefs fome fuch affiftance is given to him, there is reafon to apprehend, that he will not always execute the different bars according to their prefcribed meafures. We are told, that this was done in the performance of the choral mufic of the ancient Greeks. The coryphæus, placed in a confpicuous ftation, marked the arfis and thefis of the fucceffive feet, while others ftruck with their hands, or with the points of their fingers armed with fome hard body, each fingle time of which they were compofed. If thefe fingle intervals were ftruck with perfect uniformity, and were regularly diftributed among the different feet, according to their refpective meafures, we cannot avoid acknowledging, that, on many occafions, they did truly and accurately exprefs contiguous unequal parcels of rythmical

times. We can only ſay, that they were at much pains to counteract a ſtrong propenſity of nature, in order to attain an object, the agreeable or happy effect of which we cannot now ſo much as conceive. But it may be aſked, how are we certain that theſe ſingle times were always ſtruck in exact uniformity, or that the intervals marked by the ſtrokes were in every caſe equal? It will poſſibly be anſwered, that there was ſufficient ſecurity for this, in the ſtrong natural propenſity which all men feel to expreſs ſuch ſmall times equally and uniformly, when it is not their profeſſed intention to do otherwiſe. But ſurely the natural propenſity to aſſemble theſe times into equal parcels is alſo ſtrong, perhaps, in ſome caſes, ſtronger than the other. When theſe two propenſities, then, are ſet in oppoſition to one another, it becomes a queſtion which of them is moſt likely to prevail. We are told, that, in the performance of the Greek muſic, the propenſity to the equable expreſſion of ſingle times prevailed, and that the parcels or aggregates of them were unequal. It is certainly, however, not unnatural to ſuppoſe, that ſometimes the other propenſity might preponderate, and that ſome inequality might be admitted amongſt the ſmaller times, which were marked by the crepitacula, in order to bring the feet or parcels more nearly to equality. Theſe times and meaſures were not marked by machines, ſo conſtructed that they could never vary, nor by perſons who had no thought nor concern, but to ſtrike with the hand or fingers at equal intervals of time. The coryphæus, who regulated and conducted the performance, muſt be ſuppoſed to have been a muſician of diſtinguiſhed talents, and the ſmaller times were marked by performers, who were keenly engaged in the buſineſs that was going forward, who probably ſounded every note of the muſic, and articulated every ſyllable of the verſe. It has always appeared to me very wonderful and unaccountable, that the delicate ears of the ingenious and enlightened Greeks ſhould not only bear, but even be delighted, with what a modern cannot

hear

hear without pain and difguft; and I would very willingly fuppofe, that they made fome fuch accommodation as is hinted at above in the performance of their mufic, and that their feet or bars were fometimes unequal, more in theory than in practice. When we confider the rythmical conftitution of man, which, being a part of his nature, muft be fundamentally the fame, in all ages and amongft all nations; when we confider that thefe Greeks had a very lively feeling of the powers of rythm, and that they were accuftomed to have equal meafures frequently prefented to them in their moft popular compofitions; laftly, when we confider, that they had no written characters to reprefent fome of the proportions which may enter into the fimpleft mufic, particularly that which is marked by the point in the modern notation, and therefore could have no diftinct perception of thofe proportions, or rather might occafionally exprefs them, without being confcious of their doing fo; it does not feem impoffible, or even improbable, that their practice upon many occafions was not conformable to their theory, and that they might actually exprefs as equal thofe meafures, which, according to rule and fyftem, were unequal. After all, it is impoffible to fay, how far the power of habit may operate upon men in this as well as in every thing elfe. It muft be acknowledged, that there are various circumftances in the mufical fyftem of the ancients, befides the one that we have been now treating of, which we muft be fatisfied with contemplating and admiring at a diftance, without hoping fully to underftand them, or daring to imitate them.

To conclude this part of the fubject, the laft deviation that can be made from regular rythm, is varying the length of the unit or fingle time in the fame bar. This has never been attempted in written mufic, and can hardly be done without almoft entirely deftroying every impreffion of rythm or meafured founds.

THE regular ſtructure of rythm, and the progreſſive deviations from that ſtructure, which I have above endeavoured to deſcribe, have been chiefly conſidered as taking place in muſic. The ſame things, however, to a certain extent, may be found in poetry; and many of the obſervations which have been made upon them may be exemplified from verſes, and may ſerve to illuſtrate ſome particulars in their ſtructure. A verſe is an aſſemblage of words, which are ſo arranged, as that the long and ſhort, or the ſtrong and feeble ſyllables of which they are compoſed, may, by their ſucceſſion, give a rythm, ſuch as I have deſcribed, more or leſs regular. It muſt, therefore, be ſo conſtructed, as that the hearer may be led to form the equal or nearly equal times, which are marked by the ſyllables, into certain parcels and combinations. The ancients ſeem in general to have conſidered the time of a ſhort ſyllable, as the unit or firſt element of the rythm of poetry. According to this ſuppoſition, the feet will become analogous to the bars or firſt parcels in muſic, the verſe will be analogous to a combination or ſtrain, and the ſtanza, where it occurs, will repreſent the entire piece, which being finiſhed, the ſame rythmical air, as it may be called, is again repeated. The time in which a ſhort ſyllable is expreſſed in reciting verſes, is often too ſmall to be regularly counted and parcelled. If this is thought to be the caſe, the feet may be conſidered as units, variouſly divided and articulated by the different ſyllables which enter into them; the verſe will then correſpond to a bar, and the ſtanza to a combination. Although, however, the time in which we utter a foot is frequently not greater than what we are diſpoſed to conſider as an unit in muſic, yet, as it is always compoſed of two or more ſmaller intervals, and as we have frequent opportunities of hearing it prolonged in ſinging, ſo as to fill up the time of a bar in muſic, we are hence rather more diſpoſed to conſider the foot as a ſhort parcel or bar, than as a divided unit. The former

mer analogy, therefore, will perhaps be the moſt ſimple and obvious, and the moſt eaſily applied.

The meaſure of a verſe, or the number, according to which it is intended that the combinations ſhould be formed, may be eaſily intimated to the reader, by writing them in ſeparate lines. This contrivance, however, can be of no ſervice to the hearer. Some other means muſt be uſed to direct his attention to the number propoſed, or to make him ſtop and begin anew, after that number of equal times has been expreſſed. The very name of verſe implies a return. I formerly mentioned three different means by which this may be effected, namely, the return of ſimilar combinations and diviſions of the times, or, in other words, the return of ſimilar arrangements of long and ſhort ſounds, the return of ſounds ſimilar in kind or in quality, and pauſes. All theſe means have been employed in conſtructing verſes.

The return of ſimilar ſucceſſions of long and ſhort ſyllables at equal intervals, naturally leads the hearer to account the times which have been expreſſed during one of thoſe intervals, as one parcel or combination. This ſimilarity may either take place through the whole line, or only in a particular part of it. In the firſt caſe, when each ſingle combination is exactly ſimilar throughout, or, in the language of the grammarians, when every line contains the ſame number of feet diſpoſed in the ſame order, the return is abundantly clear and obvious, provided the ſucceſſion of long and ſhort, or of ſtrong and feeble ſyllables in the meaſure, be in any degree diverſified. We have an example of this in the aſclepiadæan verſes of the ancients. Such meaſures ſeem to have been conſidered by them as deficient in variety, and proper only for ſhort pieces. Horace has been very ſparing of them. Of all his odes, there are only ſix, in which every line is ſcanned by the ſame feet taken in the ſame order. When the cadence of the line, or the arrangement of the ſyllables, is ſuch as to ſtrike the hearer, or engage his

his attention, the frequent repetition of it, like the frequent repetition of a ſhort muſical ſtrain, can hardly fail to be in ſome degree irkſome and diſguſting. The other caſe, in which the ſimilarity takes place only in a part of the line, is more conſiſtent with variety. We have the moſt diſtinct impreſſion of a return, when the ſimilarity occurs at the end of the line. Of this we have a ſtriking example in the common hexameter verſe of the ancients. The dactylus and ſpondæus, recurring regularly at equal intervals, neceſſarily leads the hearer to conſider thoſe intervals as diſtinct combinations of equal times, although the ſame feet be diſpoſed in the other parts of the meaſure in every poſſible way. The iambus recurring at the end of iambic verſes, when diſtinctly pronounced, will give ſome impreſſion of a combination, when the rythm in the other parts of the line is very irregular. Other inſtances of the ſame kind will readily occur. Sometimes the moſt ſtriking ſimilarity takes place in the middle of the line. The dactylus, in the middle of the ſapphic verſe, ſeems to have the chief effect in forming the return of that meaſure.

When the return of the verſe, or the impreſſion which the hearer has of diſtinct combinations, is to depend chiefly upon ſuch ſimilarities, it is neceſſary, that the cadence in that part of the line in which the ſimilarity takes place, be marked, and eaſily diſtinguiſhable from that of the other parts, or that the verſe be made up of ſome diverſity of feet. When lines run uniformly by the ſame, or nearly the ſame feet, as in trochaic and iambic verſes, no ſuch diſtinct recurrences can happen. In this caſe, ſome other means muſt be uſed to give the hearer the impreſſion of a combination. A very gentle hint will incline a hearer to count off ſuch feet by combinations of the ſmaller even numbers. For this, little more is neceſſary than to write them out in ſeparate lines. The tones of voice, with which a perſon is diſpoſed to read lines of ſuch even meaſure, are often ſufficient to direct the hearer to the number according to which they

they are formed. This effect is more certainly obtained, when the verse is made to consist of an uneven number of such feet, together with an additional syllable or cæsura. As it is thus deficient of the even number by one syllable, the reader is naturally disposed to fill up the time of that syllable, either by pausing at the end of the line, or by prolonging the last or the penult syllable. In either way, he conveys to the hearer a very distinct impression of the measure. Such catalectic verses, as they are called, occur frequently in the works of the ancient poets.

Verses of the trochaic and iambic kind are often composed of some uneven number of feet, without such additional syllable. Our common English verse of ten syllables is of this form. In this case, there seems to be no rythmical means of giving the hearer an impression of the measure, but pausing a little at the end of every line. Such uneven measures naturally infer a pause. If the reader, while reciting a line, catches the idea of regular pairs, he will be disposed, by resting at the end of the line, to complete the time of his last pair. This, however, is attended with inconveniencies. The hearer is made to depend for his impression of the combination, chiefly upon the accuracy of the reader. If the latter neglects to make the proper pauses, the former may lose this impression, and may be equally disposed to form combinations of any other number. On the other hand, when there is no grammatical stop at the end of the line, when a clause of a sentence is continued from one line to another, such pauses are ungraceful; the reader, if he is more attentive to the sentiment than to the rythm, always makes them with reluctance. In such cases too, to mark the end of the line by a particular inflection of the voice, is very improper; and it is difficult to observe pauses without making such inflection.

These inconveniencies seem to furnish objections to our English blank verse, which is exactly of the nature that I have been describing,

ſcribing. This perhaps cannot with ſtrict propriety be called verſe; it wants one of the eſſential characters of verſe, a diſtinct return. The feet indeed mark times, which may be expreſſed as equal; but there is no circumſtance in the rythm to lead the hearer to form theſe times into combinations of any one number in preference to another, beſides the mere artifice of writing the intended combinations in ſeparate lines. It is impoſſible to read it, ſo as to maintain in the hearer the impreſſion of the combination, without often doing violence to the ſenſe, by ſeparating words which ought to be united. One may be eaſily ſatisfied of this, by reciting the firſt ſentence of MILTON's Paradiſe Loſt, in which almoſt every line terminates in the middle of a clauſe. In reading ſuch paſſages, the pauſes muſt often be omitted, and the meaſure ſacrificed to the ſenſe. This verſe, however, if it may be called ſuch, has been thought to be of all others the moſt proper for poems of conſiderable extent, upon ſubjects that are great and dignified: The ſeeming imperfections, which have been ſtated above, are perhaps the circumſtances which contribute to render it ſo. The alternate ſucceſſion of long and ſhort, or of ſtrong and feeble ſyllables, which generally takes place, gives a ſmoothneſs and a regular flow to the language, which ſufficiently diſtinguiſhes it from proſe, while, at the ſame time, it does not ſolicit the attention ſo ſtrongly, as to render frequent repetition diſguſtful; and the deviations which are occaſionally made from that arrangement, give a variety to the cadence, and often a very happy expreſſion to particular paſſages. The proper meaſure of the verſe, or that which ſeems intended by the poet, is often obſcured, and even changed, by the different breaks or diviſions which occur in the lines, and by the continuation of grammatical clauſes from one line to another. The unequal combinations of the feet, however, which are thus formed, like the obſcure and unequal combinations of the bars in an extended piece of ſerious muſic, both give a variety, and add a dignity and ſolemnity

nity to the movement, which it could not poſſeſs, if the combinations were always diſtinct and equal; and the frequent occurrence of lines, in which the meaſure of the verſe is clearly marked, prevents the hearer from loſing ſight of it, and alſo communicates additional pleaſure from the contraſt. This mode of compoſition ſeems thus to unite the freedom, variety and energy of proſe, with the ſoftneſs and elegance of verſe.

In lines of ſuch uniform cadence, there is no means more ſimple, or more effectual for giving the impreſſion of regular combination, than the return of ſimilar ſounds. When two contiguous verſes, of equal times, are terminated by one or more ſyllables of the ſame or nearly the ſame ſound, the hearer can find no difficulty in adopting and going along with ſuch combinations. This contrivance has been called rhyme. It is ſaid to have had its riſe from a corrupted taſte during the ages of ignorance and barbariſm. It ſtill continues, however, to be practiſed by the beſt poets, who write in the modern languages; and perhaps the conſtitution of ſuch languages does not afford a better means of conſtructing regular verſes.

In poetry, verſes may be formed according to the model of what I called regular and perfect rythm, ſo as to give the impreſſion, not only of equal parcels and combinations, but alſo of diſtinct aggregates of thoſe combinations. When ſuch aggregates conſiſt of two ſingle combinations, they are called couplets, when of more than two, they get the name of ſtanzas. We are led to form ſuch aggregates by the ſame means, by which we are led to form the ſingle combinations, namely, by the return of like cadences, by pauſes and by rhyme. When two contiguous lines rhyme together, we have the impreſſion of a couplet; when the alternate lines rhyme together, we form a combination of four. The ſame impreſſions may alſo be conveyed by other means more purely rythmical. When the lines are all equal, and made up of the ſame or equal timed feet, and the ſtanzas conſiſt uniformly of four or eight

lines, we have then a rythm perfectly regular, correſponding to the minuet or march time in muſic. Such regular ſtructure is not always obſerved. In the higher kinds of lyric poetry, it is thought to be inconſiſtent with that freedom and variety, and a check to that fire and enthuſiaſm, which ought to characteriſe thoſe compoſitions. Accordingly, the writers of lyric poetry have departed the fartheſt of any from this regular ſtructure, and have indulged themſelves in almoſt every kind of licence. The lines, of which ſtanzas are compoſed, may often conſiſt of an unequal number of ſyllables, whilſt the times employed in reciting them are ſtrictly equal, the deficiency of the ſhorter ones being compenſated by pauſes, or by lengthened ſounds. Sometimes, however, the inequality is ſo great, as to render ſuch compenſation impracticable. Such unequal lines, like unequal combinations in a muſical air, when properly introduced, may communicate a ſpirit and variety to the ſtanza, and give it a more marked and ſtriking concluſion. The adonian verſe, coming after three ſapphic lines, gives an agreeable variety and a graceful cloſe to the ſtanza. Amongſt the ancients, there are few or no inſtances of ſtanzas, conſiſting of more than four lines. The moderns, by the help of rhyme, are enabled to form larger and more variegated ſtanzas.

So long as all the lines of a ſtanza are compoſed of the ſame or of equal timed feet, the rythm may be conſidered as in ſome degree regular. Thus the hexameter and the faliſcan verſe form an agreeable couplet.

Laudabunt alii claram Rhodon, aut Mitylenen,
Aut Epheſum, bimariſve Corinthi.

The elegiac couplet is of the ſame kind. The pentameter verſe is indeed conſidered as an uneven combination. When, however, it regularly divides into hemiſtics, the pauſes, which we are diſpoſed to make at the cæſuras, fill up the whole time of the

the hexameter. Trochaic and iambic verſes may be combined into couplets in the ſame manner. When the trochaic verſe is catalectic, the deficient time at the end is made up by the firſt ſyllable of the ſucceeding iambic, and the whole combination proceeds as if it were trochaic.

> Non e|bur, ne|que aure|um
> Me|â re|nidet | in do|mo la|cunar.

The latter of theſe two combinations being uneven, the reader will be diſpoſed to pauſe at the end of it, during the time of an entire foot, and will be gratified, when the ſtructure of the ſentence permits him to do ſo. The paſſion for variety, however, could not always be confined within this limit. In the works of the ancients, we meet with couplets and ſtanzas, of which the different lines are compoſed of different and unequal timed feet. This is a further departure from regularity. It is like varying the meaſure of the bars in a piece of muſic. One of the moſt ſtriking examples of this is, when couplets are formed of hexameter and iambic verſes. Although ſuch licence may not have the ſame diſagreeable effect in poetry, that it often has in muſic, it ſeems at leaſt to give an impreſſion of incongruity, which is probably heightened by the conſtant recurrence of the different meaſures at ſtated intervals. The ſolemn and majeſtic movement of the hexameter does not ſeem to aſſort well with the airy flippant pace of the iambic. After pronouncing the latter, a perſon requires ſome time to recover that firmneſs of tone and manner, with which he is diſpoſed to pronounce the former. The 16th epode of HORACE is compoſed in couplets of hexameter and ſenarian iambic verſes, and is the only inſtance of this meaſure, which occurs in his works. In this piece, the contraſt is very ſtriking. The even lines throughout the whole of it are pure iambics, which have a more rapid movement than thoſe which are mixed. The verſes

of the Phaleucian form may be conſidered as ſhort couplets of the ſame kind.

A FARTHER deviation from regularity is when ſuch unequal timed feet are admitted into the ſame line. The mixed iambic and trochaic verſes of the ancients furniſh us with the moſt remarkable inſtance of this. I formerly ventured to expreſs a conjecture, that in the performance of the muſic, which was adapted to verſes of this kind, the ancients, by ſome means of accommodation, of which they were not diſtinctly conſcious, might occaſionally expreſs as equal thoſe contiguous feet, which, according to rule and ſyſtem, were unequal; in other words, that they ſometimes departed from the proportion of two to one, which they eſtabliſhed as ſubſiſting betwixt the long and ſhort ſyllables of words. It ſeems ſtill more probable, that they did this when reciting ſuch verſes. It is indeed difficult for us to conceive how they could do otherwiſe. In ſinging, they might be aſſiſted in expreſſing thoſe unequal meaſures with accuracy, and even, in ſome degree, conſtrained to do ſo, by ſeeing the arſis and theſis of each foot diſtinctly marked, and hearing the ſingle times uniformly ſtruck; but they could not always have the ſame aſſiſtance, when reciting. The time of a ſhort ſyllable might be counted and parcelled, when expreſſed in the continuous and more extended tones of muſic; but this could ſcarcely be done with eaſe and certainty in common ſpeech; and, without this, it is not eaſy to diſcover, how the proportions of thoſe unequal feet could be accurately expreſſed or perceived. I ſhould, therefore, be apt to ſuppoſe, that the propenſity to equal parcels or meaſures of ſyllables would prevail, as it might be gratified almoſt inſenſibly, and as there appears to be nothing of ſufficient force to counteract it. It is often difficult to determine exactly the proportional quantity of contiguous ſyllables, or to lay down any particular proportion as invariably ſubſiſting betwixt them. We can ſometimes articulate three, perhaps even four ſyllables, in our own language, in

in no longer time than we employ in expreffing one fyllable in the fame fentence. It would be rafh, however, upon perceiving this, to affert, that the one fyllable was in quantity triple or quadruple of the others, as in different occurrences, or in different arrangements of the fame fyllables, the proportion might be varied. We can, with great eafe, contract or extend a fyllable, when we wifh to make it a certain component part, or the whole of a determined interval of time, upon which we have fixed our attention. It is hard to fuppofe, that in the Greek and Latin languages, which are compofed of the fame fimple elements with ours, no proportion fhould fubfift betwixt contiguous fyllables, but that of equality, or that of two to one, or fome obfcure or ill defined proportion approaching to thefe; and it is ftill harder to fuppofe, that thefe proportions were conftant and invariable, in every fituation and occurrence.

The trochæus and fpondæus might be rendered equal in recitation, either by contracting the latter to the time of the former, or by extending the former to that of the latter. The one or the other of thefe practices might be adopted in different cafes, according to the different ftructure of the fyllables of which the feet were compofed. That there was a tendency to prolong the trochæus, we are almoft inclined to believe, from the firft fyllable of that foot being regularly placed in the ftrongeft and moft emphatic part of the meafure. It is well known, that in conftructing mixed trochaic verfes, the trochæus was made to occupy the firft, third and other uneven places; the even places were occafionally filled with fpondæus, or other feet of four times. In iambic verfes, again, the even places were kept facred to the iambus. If, however, we confider the firft fyllable of thefe verfes as introductory, and fuppofe the meafure to begin with the fecond fyllable, which we are much inclined to do, we reduce them to trochaics, in which alfo the trochæus will be regularly found in the uneven places of the meafure.

It

It is not always ſafe indeed to reaſon from general principles and analogy upon matters of fact, more eſpecially when ſuch reaſoning appears to be contradicted by poſitive teſtimony. I therefore offer theſe conjectures with diffidence. The accent and manner of pronunciation of the ancients being now irrecoverably loſt, we have no means of having the matter ſubjected to ſenſible demonſtration. All that we can ſay is, that if they did in fact pronounce theſe unequal feet in their juſt proportions, and were conſcious of doing ſo, they poſſeſſed a power of combining very ſmall intervals of time into unequal parcels, to which perhaps no parallel can be found in modern days.

IV.

IV. *On certain* Analogies *observed by the* Greeks *in the Use of their* Letters; *and particularly of the* Letter ΣΙΓΜΑ.

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INTRODUCTION.

THE power of pronouncing articulate sounds is one of the most obvious marks which distinguish man from the other animals. No philosophical investigation is necessary for pointing it out, and therefore it has not escaped the notice of the poets, the most ancient of all authors. In the works of Homer and Hesiod *, we often meet with the expression *μέροπες ἄνθρωποι, men having an articulate voice;* the word *μέροψ* being evidently compounded of *μείρω, to divide,* and *ὄψ, the voice* †.

But

* *Vide Iliad.* ά, 250. γ', 402. σ', 288. *&c.* *Oper. & Dies,* 109, 142. Anacreon has also made use of the same epithet, but without the substantive; *Od.* III. 4.

† Διὰ τὸ μεμερισμένην ἔχειν τὴν ὄπα, says Hesychius, *voce* μέροπες. In which Suidas agrees. Eustathius is more explicit. Μέροπες οἱ ἄνθρωποι, παρὰ τὸ φύσει μεμερισμένην ἔχειν τὴν ὄπα εἰς τε λέξεις καὶ εἰς συλλαβὰς καὶ εἰς στοιχεῖα, ὃ μηδεμία τις ἄλλη ἔχει φωνὴ παρὰ τὴν τῶν ἀνθρώπων αὐδήν. *Men are called* μέροπες, *from their naturally having their voice divided into Words and Syllables and Elements, a quality which no voice possesses, except human Speech.* Ad Iliad. ά, 250. The Bishop adds, That "those of his own sacred society, "the interpreters of holy Writ, derive the word from the division of tongues which "took place at the building of the tower of *Chalana,*" as he calls it; which etymology Erasmus has also taken notice of in his Dialogue *de recta Latini Græcique Sermonis pronuntiatione.*

But although man is plainly poſſeſſed of this faculty of articulation, or pronouncing diſtinct ſyllables; yet the analyſis of thoſe ſyllables into their conſtituent parts, or ſimple elements, or into what the Greek writers call *ϛοιχεῖα*, muſt originally have been a work of immenſe ingenuity. Perhaps it would even have been impracticable ever to have made a complete analyſis of this kind, without the invention of viſible ſigns for denoting each of thoſe elements. Nor hath any ſort of ſigns, ſymbols or characters been found ſo proper for that purpoſe, as thoſe which we call *Letters*. Indeed, it ſeems impoſſible to comprehend any other viſible mode of analyzing words into ſyllables, and ſyllables into ſimple elements, than that which is furniſhed by letters. For though we can conceive language to be, in ſome degree, conveyed by marks of imitation; as when, in expreſſing *an elephant*, we ſhould ſet down the figure of that animal: yet we could never analyze ſuch a repreſentation, ſo as to convey any idea of the different ſyllables in the word *elephant*, or of the elemental ſounds of any of thoſe ſyllables *.

Indeed, the ſignificant ſounds of a language, even conſidered each in the aggregate, and without any reſolution into its conſtituent

nuntiatione. But of this derivation, Damm, in his Lexicon, juſtly ſays, "Id piè magis "quam verè." Eustathius has farther obſerved, "That certain birds are called "*μέροπες*;" thoſe, no doubt, he means of the parrot kind. But the manner in which theſe poſſeſs the faculty of articulation, forms but a very ſlight exception to this characteriſtic of human nature. Human articulation was defined by the Stoics as follows: *Φώνη ἔναρθρος καὶ ἀπὸ διανοίας ἐκπεμπομένη*, *Sound articulate, and proceeding from Sentiment*. See Harris's *Hermes*, p. 322.

* Even Dr Wilkins's *Real Character*, which he has, with ſuch aſtoniſhing labour, invented, is not calculated to give any idea of ſyllables or elemental ſounds; and therefore, in order to complete his ſcheme of an univerſal philoſophical language, he has likewiſe invented two alphabets, one of which he calls a *Natural Character*; this being neceſſary for the expreſſing of proper names, according to his project. See *An Eſſay towards a real Character and a philoſophical Language, by* John Wilkins, D.D. *Dean of Ripon, and* F.R.S. (*afterwards Biſhop of Cheſter.*) Lond. 1668. fol.

constituent elements, can be but very imperfectly expressed by figures of imitation; because there is of these sounds an immense variety, which cannot possibly admit of any such visible exhibition *. Those conventional signs, which we call letters, are the only proper and complete mode of denoting simple elemental sounds, and their infinite variety of combination in syllables and words. For although the alphabet of no one language contains a sufficient number of letters to express every possible modification of articulated sound; yet the letters composing the several alphabets of those written languages with which we are acquainted, especially the ancient Greek and Latin, have been found sufficient for denoting all the requisite elementary sounds in those particular languages †.

LETTERS are called by the Greeks *γράμματα*, a word whose etymology is evident; for if *γράφω* signify *to write*, *γράμμα* must signify *a thing written*, that is, a letter, or written character, denoting an element of articulate sound ‡. The ori-

* SEE an excellent account of the difference betwixt imitative and symbolic language, by the late Mr HARRIS, supported by quotations from Greek authors. *Hermes*, *Book* III. *Chap.* 3.

† Dr WILKINS has endeavoured to shew the defects in common alphabets, as to the true order of the letters, their just number, determinate powers, fitting names, proper figures, *&c.* *Essay towards a real Character*, &c. *Part* I. *Chap.* v. And he has exhibited a table of such simple sounds as he thinks can be framed by men, with a twofold instance of a more regular character for the letters, together with several other curious particulars. *Part* III. *Chap.* x. xi. xii. xiii. xiv. After all, he concludes as follows: "These thirty-four letters, before enumerated, will suffice to express all those articulate "sounds, which are commonly known and used in these parts of the world. I dare not "be over-peremptory in asserting, that these are all the *articulate Sounds*, which either "are, or can be in nature; it being as impossible to reckon up all such, as to determine "the just number of *Colours* or *Tastes*."

‡ THE etymology of the Latin word *Litera*, is not so well ascertained. See SCALIGER *de Causis Ling. Lat. Lib.* I. *Cap.* 4. AMMONIUS the Grammarian thus defines the difference betwixt γράμμα and στοιχεῖον. Γράμμα Στοιχείου διαφέρει. Στοιχεῖον μὲν γὰρ ἐστιν ἡ ἐκφώνησις καὶ ὁ φθόγγος, ὃ τὸ γράμμα ἐστὶ σημεῖον ἢ τύπος ἢ σχῆμα. Γράμμα *differs from* στοιχεῖον. *For* στοιχεῖον *is the enunciation and the sound, of which* γράμμα *is a sign or type or figure.* De affinium vocab. differentiâ, voce γράμμα, ubi vide quæ annotavit vir doctissimus LUD. CASP.

ginal ſignification, however, of *γράφω* was not preciſely what we now mean by the expreſſion *to write*. In the earlieſt times of the Greek language, it meant *to carve;* and as the moſt ancient method of writing was to carve ſome ſort of figures upon tables of wood or braſs, which was expreſſed by *γράφειν*, (as we learn from HOMER *), that verb remained in uſe to expreſs the

CASP. VALCKENAER. ARISTOTLE gives the following account of an element. Στοιχεῖον μὲν οὖν ἐστι φωνὴ ἀδιαίρετος· οὐ πᾶσα δὲ, ἀλλ' ἐξ ἧς πέφυκε συνετὴ γίνεσθαι φωνή. καὶ γὰρ τῶν θηρίων εἰσὶν ἀδιαίρετοι φωναὶ ὧν οὐδεμίαν λέγω στοιχεῖον. *An Element is an indiviſible ſound; not every indiviſible ſound, but from the compoſition of which an intelligible ſound* [or word] *is naturally produced. For the cries of wild animals are indiviſible ſounds, but I call none of theſe an Element.* De Poetic. cap. xx. See alſo DIONYS. Halicarn. de Compoſ. Verb. cap. XIV. et PLATO in Cratylo. Vol. I. p. 426. Edit. SERRANI. See the Stoic definition of an element, quoted by Mr HARRIS from DIOGENES LAERTIUS: *Hermes*, Book III. chap. 2. But though *γράμμα* and *στοιχεῖον* are clearly different, the one ſignifying a letter and the other an element, they are frequently confounded by the Greek writers; the ſign being often taken for the thing ſignified. Accordingly, DIONYSIUS the Thracian, in giving the etymology of the words, has confounded their meaning. Γράμματα δὲ λέγεται διὰ τὸ γραμμαῖς καὶ ξυσμαῖς τυποῦσθαι. γράψαι γὰρ τὸ ξύσαι παρὰ τοῖς παλαιοῖς, ὡς καὶ παρ' Ὁμήρῳ. [Iliad. λ', 388.] Τὰ δὲ αὐτὰ καὶ στοιχεῖα καλεῖται διὰ τὸ ἔχειν στοῖχόν τινα καὶ τάξιν. *They are called γράμματα, on account of their being formed by lines and inciſions: for γράψαι, among the ancients, ſignified to make an inciſion, as we find from* HOMER, [Iliad. λ', 388.] *The ſame are called στοιχεῖα, becauſe they are arranged according to a certain progreſſion or ſeries.* Ars Gramm. apud FABRICIUM in Biblioth. Gr. Vol. VII. p. 27. Nor has THEODORE GAZA attended to the diſtinction in his definition, though it is, in other reſpects, extremely accurate. Ἀρκτέον δ' ἴσως ἀπὸ τοῦ πρώτου, εἴη τῶν στοιχείων. ταῦτα γὰρ ἡ πρώτη καὶ ἀμερής ἐστι τ' ἀνθρώπου φωνή, οὐ γὰρ ὡς ἔτυχεν συμπλέκεται ἀλλήλοις εἰς σύστασιν συλλαβῆς, ἀλλ' ὡς καὶ τοὔνομα δηλοῖ, στοίχει τε καὶ εὐτάκτως κινούμενά πως συντάσσεται κατὰ λόγον. *Perhaps we ſhould begin with the firſt,* viz. *the Elements. For they are the firſt and indiviſible voice of man; not being connected together at random, to produce the compoſition of a ſyllable; but, as the name imports, arranged in a rational manner, advancing in a certain ſeries and regular order.* Grammat. Inſt. Lib. IV. PRISCIAN has remarked this confounding of an element and a letter: " Abuſivè tamen et elementa pro literis et literæ pro elementis vocantur." Lib. I. In moſt caſes, however, no great inconvenience ariſes from the neglect of this diſtinction.

* Πέμπε δέ μιν Λυκίηνδε, πόρεν δ' ὅγε σήματα λυγρὰ,
Γράψας ἐν πίνακι πτυκτῷ θυμοφθόρα πολλά. Iliad. ζ, 168.

which, tranſlated literally, runs thus: *He ſent him into Lycia, and he moreover gave him deſtructive ſigns, having carved, upon a folding tablet, a variety of them fatal to his life.* The poet is ſpeaking of PROETUS, who ſent BELLEROPHON into Lycia with this fatal tablet.

the more commodious method of writing which was afterwards invented.

In whatever part of the world, or at whatever time, the uſe of letters took its origin, (for I do not mean at preſent to enter upon that inquiry *), it cannot be denied that it is one of the moſt admirable of all human inventions. That we ſhould be able, by means of twenty-four viſible characters, to denote the various thoughts of our minds, uttered by articulate ſounds, ſo as not only to convey them to perſons abſent and at a diſtance, but even to tranſmit them to poſterity, muſt, if it did not, as ſome ſuppoſe, proceed immediately from the Deity, be conſidered as the moſt eminent of all the improvements which human art has yet made of thoſe powers which he has been pleaſed to beſtow upon our ſpecies †.

Indeed,

tablet. We have no authority to tranſlate σήματα, *Letters*, or γράψας, *having written*, as is generally done. Indeed, no where in the poems of Homer, do we find any part of the ſimple verb γράφω, except here, and in the 599th line of the 17th book of the Iliad, where γράψεν occurs; and there it ſignifies *to wound*, or *to make an inciſion*, being applied to what the ſpear of Polydamas did to Penelaus the Bœotian. Its compound ἐπιγράφω indeed is found four or five times, and always ſignifies *to raze* or *graze* the ſkin with the point of a weapon. But neither γράμμα nor στοιχεῖον are to be met with in Homer, nor does he any where make mention of Letters or writing by any terms whatever. For σῆμα, which occurs ſo often, can ſcarcely ever be ſaid to ſignify what we mean by a *Letter*: And hence an argument has been adduced, though not by any means a deciſive one, againſt Homer's knowledge of the art of writing, or the uſe of letters. But this is an inveſtigation which cannot properly be introduced in a note. See what the late Mr Robert Wood has written upon this ſubject in the laſt ſection of his *Eſſay on the original Genius of* Homer. Lond. 1775. 4to.

* See a ſhort but elegant Diſſertation, printed at the concluſion of the 2d Vol. of Havercamp's *Sylloge Scriptorum qui de Ling. Græc. verâ et rectâ pronuntiatione commentarios reliquerunt*, entitled, *De Fœnicum Literis*, &c. Guillielmo Postello *Barentonio auctore*. See alſo Harris's *Hermes*, *Book* III. *ch*. 2.

† " La communication des penſées par l'Ecriture, n'eſt guères moins admirable que " celle qui ſe fait par la Parole. Ce ne fut apparemment qu'apres bien des meditations " et des eſſais multipliés, que degoûté des difficultés, des équivoques, des obſcurités, des " bornes trop etroites de l'écriture hiéroglyphique, l'inventeur de l'ecriture littérale re-

" connut

Indeed, the faculty of ſpeech itſelf, not to mention the various arts and ſciences, could not have been brought to any conſiderable degree of improvement, without the aſſiſtance of written language. Without this, the knowledge of one age of the world could not have deſcended diſtinctly to another, and conſequently mankind muſt, in a great meaſure, have loſt thoſe advantages which they derive from the accumulated experience of former times.

The variety of languages, however, both written and ſpoken, which takes place in the world, has been matter of regret to thoſe who have conſidered the ſubject particularly; and it has been wiſhed, that a method of ſpeech, capable of being conveyed by writing, had been invented, which mankind, at leaſt in every poliſhed nation, might have been able univerſally to adopt and to underſtand. But the diſtribution of the world into ſo many different kingdoms and nations, ſeems to render the introduction of an univerſal language among mankind quite impracticable *. For although men poſſeſs

" connut le nombre aſſez petit des ſons élémentaires, et comprit qu'en les repréſentant " par autant de caractères diſtincts, on pourroit combiner ces caractères comme les ſons " qu'ils repréſentent ; ce qui conſtitue en effet

" ———— *Cet art ingenieux*
" *De peindre la parole, et de parler aux yeux ;*

" art merveilleux, qui fixe à jamais la parole et la penſée qu'elle exprime, qui porte " l'une et l'autre aux abſents, qui les fait paſſer à la poſtérité la plus reculée, et dont on " peut dire avec vérité et ſans reſtriction, ce que dit M. Diderot d'un idiome qui di- " viendroit commun à tout le genre humain : [*Encyclop. au mot* Encyclopedie.] que " par ſon moyen, *la diſtance des temps diſparoît, les lieux ſe touchent, il ſe forme des liaiſons* " *entre tous les points habités de l'eſpace et de la durée, et tous les êtres vivants et penſants* " *s'entretiennent.*" Grammaire Generale, &c. Par M. Beauzee. Tom. I. p. 2. See alſo Ciceron. *Queſt. Tuſc.* Lib. I. and Wilkins's *Eſſay*, &c. p. 10.

* The ingenious, laborious and truly admirable effort of Dr Wilkins, to invent and eſtabliſh an univerſal character and philoſophical language, has only tended to ſhow more ſtrikingly the impracticableneſs of ſuch an attempt : At leaſt, however feaſible his project may appear, his method ſtill remains unemployed by the learned ; and as for the vulgar, it is quite beyond their comprehenſion.

possess universally the same organs of speech, and, by means of these, the same faculty of uttering articulate sounds; yet the manner of exerting those organs, so as to produce a particular language, being quite arbitrary, is a work, at first, of accident, and then of gradual improvement, and which cannot be carried forward, even by the help of writing, without a frequent intercourse, and a sort of mutual convention among the individuals of that society, who find it for their advantage to adopt such a language *. But an intercourse adequate to such an end cannot take place beyond a particular nation; therefore an universal living language cannot possibly subsist: For, according to an observation of D'ALEMBERT, "There is nothing, "either in nature or in reason, which determines an object to "be designed by one sound more than by another." To which BEAUZEE adds, That "there is nothing in nature or reason "which determines a sound to be designed by one letter more "than by another †." Accordingly, a variety of different tongues

* THE inhabitants of some nations, says M. DU MARSAIS, employ certain organs, and even certain parts of organs, of which others make no use. There is likewise a particular form or manner of exerting the organs, &c. "Il y'a des peuples qui mettent en "action certains organes et même certaines parties des organes, dont les autres ne font "point d'usage. Il y'a aussi une forme ou maniere particuliere de faire agir les organes. "De plus en chaque nation, en chaque province, et même en chaque ville, on s'enonce "avec un sorte de modulation particuliere; c'est qu'on appelle *accent national*, ou *accent* "*provinciale.*" *Encyclop. au mot* CONSONNE.

† "SI, comme le dit l'illustre Secrétaire de l'Academie Françoise, *il n'y a rien* "*dans la nature ni dans la raison qui détermine un objet à être designé par un* "*son plutot que par un autre;* on peut dire avec autant ou plus de vérité, qu'il n'y a "rien dans la nature ni dans la raison qui détermine un son à etre designé par une lettre "plutôt que par une autre." *Gramm. Generale, par* M. BEAUZEE. Tom. I. p. 179. See also p. 233, 234.

Dr WILKINS indeed has endeavoured to contrive a set of characters, which, in their shape, have "some resemblance to that configuration which there is in the organs of "speech upon the framing of several letters." Upon which account, he thinks, such an alphabet may deserve the name of a *natural character* of the letters. *Essay*, &c. p. 375. But here he has not been very successful; and indeed he seems himself to prefer another alphabet, which he has also set down, although it has no such property, and yet is, as he confesses, "more facile and simple."

tongues has prevailed ever ſince the early ages of the world; and ſuch of them as have ceaſed to be ſpoken would have ſoon periſhed, had they not been committed to writing; by which means, ſome of them have ſurvived the wreck of nations, and the other viciſſitudes of human affairs. Of theſe, though their genuine pronunciation be now, in a great meaſure, loſt, we are ſtill able, after a conſiderable degree of pains, not only to underſtand the meaning, but even to perceive the beauties; and, among the various ſorts of inſtruction which they convey, we derive from them many eſſential advantages in improving and poliſhing our own language.

To none have we been more indebted in theſe reſpects, than to the language of the ancient Greeks. As this is acknowledged, by all who have ſtudied it, to be the moſt perfect *; ſo the analogy perceived from an attentive obſervation of its ſtructure, even in the moſt minute parts, is of all others the moſt complete and beautiful. Whence the Greeks borrowed their alphabet, which they uſed with ſuch ſucceſs, I am not here to enquire. That it did not originate with themſelves, is univerſally agreed among the learned †. But it is no leſs certain,

* See Mr Harris's elegant encomium of the Greeks and their language, of which he was the great and rational admirer. *Hermes, Book* III. *Chap.* 5. Alſo, Dr Gregory Sharpe, in the Preface to his *Origin and Structure of the Greek Tongue.*

† It is the uniform opinion of ancient authors, that the Greek alphabet at firſt conſiſted only of ſixteen letters, which were imported out of Phœnicia into Greece by the celebrated Cadmus. [See Herodot. *Terpſichor.* cap. 58. Plutarch. *Sympoſ.* lib. 9. Iren. lib. I. cap. 12. Lucan. *Pharſ.* lib. III. See alſo, Dr Wilkins's *Eſſay*, p. 11.] Theſe ſixteen letters, called Καδμηΐα γράμματα, and ſometimes σήματα Κάδμυ, were the two ſhort vowels with the three *ancipites;* the three ſmooth and the three intermediate mute conſonants; and the four liquids, with the ſolitary Σῖγμα. Palamedes is ſaid to have added the three aſpirated mutes, and the double conſonant Ξῖ, at the time of the Trojan war. And Simonides is ſuppoſed afterwards to have invented the two other double conſonants and the two long vowels. See Montfaucon. *Palæogr. Gr.* p. 115, 116, 117. And ſee an enumeration of the authors who have written on this ſubject in Theophili Christoph. Harles *Introd. in Hiſt. Ling. Gr. Proleg.* p. viii. ſeqq. *Altenburg.* 1778. 8*vo.*

tain, that wherever they got the firſt ſketch of an alphabet, they improved it very much, not indeed inſtantly, but gradually, till they brought it to that ſtate in which we now ſee it, in the twenty-four different characters whereof it is compoſed *.

To point out completely the analogy which the Greek writers obſerved in the uſe of each of thoſe letters, would lead into a very wide field. At preſent, I propoſe only to enquire particularly into the nature and principal uſes of one of them, I mean the *Σῖγμα*. This, being the ſign of a ſingular ſort of ſound, has been uſed, in the ſtructure of the Greek tongue, in a manner different from every other letter; and therefore the Grammarians have generally allotted to it a ſingular place in their arrangement of the different component members of the Greek alphabet. It will be impoſſible, however, to treat of the *Σῖγμα*, without making mention of certain circumſtances incident to the other conſonants.

PART I.

THE letter *Σῖγμα* was commonly ſo called by the inhabitants of Greece, its iſlands and colonies, except the Dorians, who, as we learn from HERODOTUS, gave it the name of *Σάν* †. DIONYSIUS of Halicarnaſſus alſo mentions this Doric

* CALLISTRATUS, the Grammarian of Samos, is ſaid to have arranged the Greek alphabet in the order in which we now find it, when EUCLIDES was Archon of Athens. See FOSTER's *Eſſay on Accent and Quantity*, p. 41. 2d Edit.

† *Δωριέες μὲν τὸ σὰν καλέουσι, Ἴωνες δὲ σίγμα.* Lib. I.

Doric name *; and ATHENÆUS further obſerves, that ARISTOPHANES, in his comedy of *The Clouds*, has called thoſe horſes who had this letter branded upon them, Σαμφόραι †. It has been by ſome thought abſurd, that the letters, which are the ſigns of elemental ſounds, ſhould be called by any other names than the mere ſounds which they denote. It may be ſaid, however, in favour of the Greek names, that they always begin with the letter whoſe power they denote; and it is a good practical rule in grammar, to ſay, " That the power of " each letter may be known by catching the initial ſound of the " name ‡." In ſpeaking particularly of the letters, it is neceſſary to have a diſtinct articulate name to give to each of them, becauſe the mere power, eſpecially of the mute conſonants, can ſcarcely be uttered without a vowel; and if the aſſiſtance of a vowel be employed in uttering them, then you give them a name ſomewhat different from their real power, and more likely to lead into error.

WITH reſpect to the elemental ſound of which Σῖγμα is the ſign, there is no doubt that the Greeks uſed that letter to expreſs preciſely what we denote in Engliſh by the letter S in ſuch words as the following, *ſame*, *deſignation*, *diſtreſs*. This we learn from a diſtinct deſcription, which DIONYSIUS of Halicarnaſſus has given of the poſition and effort of the vocal organs in the pronunciation of this letter. " The Σῖγμα, ſays " he, is pronounced by an appulſe of the tongue to the palate, " while

* HE mentions it as ſo called by PINDAR. *De compoſitione Verborum*, *Sect*. 14. of which more afterwards.

† ATHENÆUS, p. 467. *Edit. Commelin.* See alſo ISAACI CASAUB. *Animadverſſ. in* ATHEN. Lib. X. cap. 21. Σαμφόραι is evidently compounded of Σὰν and φέρω, being always μ before π, β, φ, which will be remarked more particularly afterwards. See ARISTOPHANIS *Nubes*, 122. 1298. *Edit. Brunck. Argentor.* 1783.

‡ LITERÆ cujuſque vis intelligitur ex initiali ſono nominis. MOOR *Elementa, L. Gr.* p. 2.

" while the breath rushes through the middle part of it, and " emits a gentle and constricted sibilation about the teeth *." The name itself is evidently derived from *σίζω, to hiss;* and from the hissing sound of which it is the sign, it has been called the serpentine letter. Some have even fancied, that various shapes of the serpent have been copied in the different forms it has assumed †. The forms most commonly in use, are two for the large or capital letter, thus Σ, *C*, and three for the small one, thus σ, *C*, ς, of which the last is always final, the other two initial or intermediate ‡. In order to comprehend more distinctly the use of the Σῖγμα, it will here be proper to take a short view of the other consonants.

* Το——σ [ἐκφωνεῖται] τῆς μὲν γλώσσης προσαναγομένης ἄνω πρὸς τον οὐρανὸν, τοῦ δὲ πνεύματος διὰ μέσου αὐτοῦ φερομένου καὶ περὶ τοὺς ὀδόντας λεπτὸν καὶ στενὸν ἐξωθοῦντος τὸ σύριγμα.

Ceratinus's definition is nearly the same: " Profertur lingua sursum adducta ad pa- " latum, cujus medio spatio spiritus fertur et circa dentes exilem et angustum et quodam- " modo tristem sibilum expellit." *De Sono Gr. Litt. Libellus.* It ought never to be pronounced, as in some English and French words, as if it were the same with Z, or a double S. " Hic quidem certe graviter errant et labuntur præter cæteros Galli, quoties " σῖγμα interjacet duabus vocalibus in una vel diversis dictonibus. Tum enim sonus qui " est in ζῆτα, vel in Zain Hebræorum ex eo percipitur: ac perinde pronuntiatur ac si " μοῦζα scriberetur. Quod certe vitium dum nonnulli subterfugere ac devitare volunt, " utinam in alterum minime inciderent, nec quasi per geminum SS esset scriptum mussa " proferrent." Hen. Steph. *Apologet. pro vet. L. Gr. Pron.* In which opinion Lancelot agrees. " Sa prononciation doit estre ferme et entiere, aussibien entre deux " voïelles qu'en tout autre lieu. C'est pourquoi il le faut prononcer dans Χρύσης de mê- " me que dans σῦς tuae: quoiqu'en François nous prononcions autrement Chryses que " Ses." *Nouvelle methode pour apprendre facilement la Langue Greque,* p. 16.

† " Sigma—merus est sibilus: ideoque ab Hebræis specie quadam serpentis caudam " ad caput retorquentis, et a Græcis, in gyrum sese revolventis, hac videlicet figurâ Σ· " vel veluti caput vibrantis, ut σ: denique ut sese sinuantis, pingitur, nempe *C* quam fi- " guram Latini imitati." Beza *de pronunt. Gr. L.* p. 21. *Edit.* H. Steph. 1587.

‡ Father Montfaucon has given ten different figures of the Σῖγμα, and mentioned the different periods when each of them was used. *Palæogr. Gr.* p. 336, 337. " The " disability of pronouncing this letter is called *Blæsitas, Lisping,* whence it is corruptly " sounded like (*th.*)" Wilkins, p. 369.

The general difference betwixt vowels and conſonants has been very accurately ſtated by Dr Wilkins, in the following words: " Thoſe letters are called *Vocales*, vowels, in pronouncing of " which by the inſtruments of ſpeech, the breath is freely " emitted; and they are therefore ſtyled *Apert*, or open letters. " Thoſe letters are ſtyled *Conſonants*, in the pronouncing of " which the breath is intercepted by ſome colliſion or cloſure " amongſt the inſtruments of ſpeech; and for this reaſon are " they ſtyled *Clauſæ Literæ* *."

The ſeventeen Greek conſonants were divided by the elder grammarians into eight ſemivowels and nine mutes. " Of the " conſonants, ſays Theodore Gaza, ſome are ſemivowels, " as ζ, ξ, ψ, λ, μ, ν, ρ, σ, of which ζ, ξ, ψ, are double, and " λ, μ, ν, ρ, are immutable and liquid †." According to this arrangement, σ is a ſemivowel; but in the ſubdiviſion of the ſemivowels into double conſonants and liquids, it is tacitly omitted. For this Gaza had the authority of Dionysius the Thracian ‡, and probably of Apollonius Dyscolus, whom he very much followed. Constantine Lascaris has expreſſed himſelf very nearly in the ſame words §. But Emanuel Chrysoloras is more explicit. His Grammar is in the form of queſtion and anſwer. " How are " the ſeventeen conſonants divided? Into two ſorts, ſemivowels " and mutes. How many are ſemivowels? Eight, ζ, ξ, ψ, λ, μ, " ν, ρ, σ. How are the ſemivowels divided? Into three ſorts, " double conſonants, immutable conſonants, and σ. How ma-" ny

* *Eſſay towards a real Character*, &c. p. 363. and 366.

† Τῶν δὲ συμφώνων, τὰ μὲν ἡμίφωνα, οἷον ζ. ξ. ψ. λ. μ. ν. ρ. σ. ὧν διπλᾶ μὲν ζ. ξ. ψ. ἀμετάβολα δὲ καὶ ὑγρὰ λ. μ. ν. ρ. Theod. Gazæ *Introductionis Grammaticæ libri* IV. *fol.* 3. *Baſil. apud* Valent. Curionem. 8vo.

‡ *Vide* Dionysii *Thracis Art. Grammat.* Extat in Fab. *Biblioth. Gr.* Vol. VII. p. 26.

§ *Vide* Constantini Lascaris *Grammaticæ Compendium*, p. 2. *apud* Paulum Manutium, Aldi F. *Venet.* 1557. 12mo.

" ny are double? Three, ζ, ξ, ψ. How many are immutable? " Four, which are alſo called liquids, λ, μ, ν, ρ *." The remaining nine conſonants are called mutes by all the grammarians: Of which three, to wit, π, κ, τ, are termed ψιλὰ, *ſmooth;* three, to wit, φ, χ, ϑ, are δασέα, *rough*, or *denſe;* and three, to wit, β, γ, δ, are μέσα, *intermediate;* in ſuch a manner, that each ſmooth one has an intermediate and a denſe one to correſpond to it, which three are ſaid to be of the ſame rank, becauſe they nearly reſemble each other in the manner in which the vocal organs exert themſelves in pronouncing them; the firſt rank π, β, φ, being *labial*, the ſecond κ, γ, χ, being *palatine*, and the third τ, δ, θ, being *dental*, as is well known to every one who has the ſmalleſt acquaintance with the principles of the Greek tongue. Aristotle has defined, with his uſual acuteneſs and preciſion, the difference betwixt a vowel, a ſemivowel and a mute. " A vowel (ſays he) is that which, " without any alliſion of the organs, hath an audible ſound, " as α and ω. A ſemivowel is that which, with an alliſion, " hath an audible ſound, as σ and ρ. A mute is that which, " with an alliſion, hath by itſelf indeed no audible ſound, but " is audible in conjunction with the vowels, as γ and δ †."

I am ſenſible that the arrangement of the conſonants by the Greek grammarians, has not been approved of by ſome late writers on the ſubject of grammar; and there is no doubt but another might be ſhewn which would ſeem better adapted to the

* Εἰς πόσα διαιρῦνται τὰ δεκαεπτὰ σύμφωνα; εἰς δύο, εἰς ἡμίφωνα καὶ ἄφωνα. πόσα ἡμίφωνα; ὀκτὼ ζ, ξ, ψ, λ, μ, ν, ρ, σ. εἰς πόσα διαιρῦνται τὰ ὀκτὼ ἡμίφωνα; εἰς τρία, εἰς διπλᾶ, εἰς ἀμετάβολα, καὶ εἰς το σίγμα. πόσα διπλᾶ; τρία, ζ, ξ, ψ. ποσα ἀμετάβολα; τέσσαρα, ἃ καὶ ὑγρὰ λεγονται, λ, μ, ν, ρ. Emanuelis Chrysolorae *Gr. Gram. Inſtitutiones. Ven. apud* Jo. Farreum *et Fratres.* 12mo. *Paginis deſunt numeri.*

† Ἔστι δὲ φωνῆεν μὲν, ἄνευ προσβολῆς ἔχον φωνὴν ἀκυστήν. οἷον, τὸ α καὶ ω. Ἡμίφωνον δὲ, τὸ μετὰ προσβολῆς ἔχον φωνὴν ἀκυστήν· οἷον, το σ, καὶ τὸ ρ. Ἄφωνον δὲ, τὸ μετὰ προσβολῆς καθ' αὑτὸ μὲν ὐδεμίαν ἔχον φωνὴν, μετὰ δὲ τῶν ἐχόντων τινὰ φωνὴν γινόμενον ἀκυστόν· οἷον, τὸ γ καὶ το δ. Περὶ Ποιητ. Κεφ. κ'.

the natural order of the elemental ſounds, and the affinity ſubſiſting among certain claſſes of ſuch ſounds. All ſuch as are labial, for inſtance, might be claſſed together, whether mutes or ſemivowels, as β, μ, π, φ, ψ; all ſuch as are dental, to wit, ζ, ϱ, σ; all ſuch as are lingual, to wit, δ, θ, λ, ν, τ; and all ſuch as are palatine, to wit, γ, κ, χ, ξ. And accordingly this has been done by HULEWICZ, one of the beſt modern writers on Greek grammar *. But this he has propoſed, without rejecting the uſual arrangement, which he knew to be ſo important in examining or explaining the ſtructure of the Greek tongue. For though a diviſion and arrangement of that ſort might anſwer the purpoſe of a minute anatomical or phyſiological inquiry concerning the organs of ſpeech, yet as this was not the circumſtance chiefly attended to by the Greeks in the progreſs of their language, though they did not by any means neglect it, we muſt adhere to that other diſtribution by the grammarians, if we would wiſh to comprehend clearly the real uſe of the Greek letters. There is, for inſtance, no doubt that μ is a labial conſonant, as well as π, β, or φ· and in fact the Greeks in ſome meaſure attended to this, as will be afterwards ſhewn; but the uſe of μ as a liquid, and its partaking in this reſpect of the ſame analogy with λ, ν, ϱ, was a connection much more ſtriking, and much more attended to in the practical application of the Greek alphabet †. In the caſe of the nine mutes, it is of very great conſequence to conſider how, in

* *See* ALEX. GABR. WOIUTYN HULEWICZ, *nobilis Poloni, Inſtitutiones Ling. Græcæ*, p. 14. *Lugd. Bat.* 1746. 4*to*. M. BEAUZEE, an ingenious French Grammarian, has alſo propoſed a very minute arrangement of the letters, according to an idea of this kind. See *Grammaire Générale, ou Expoſition raiſonnée des Elemens neceſſaires du Langage*. 2 tomes, Paris, 1767. 8*vo*. See alſo *Biſhop* WILKINS's *Eſſay*, &c. p. 357.

† "Appellantur LIQUIDÆ,——quod poſt mutam poſitæ quaſi liqueſcentes ac evaneſ-
"centes, vim conſonantes interdum amittant, neque vocalem præcedentem longam effi-
"ciunt, ut aliæ conſonantes." ANTESIGNANUS *apud* CLENARDUM, p. 3. *Hanoviæ*, 1617. 4*to*.

in the inflections, and in certain other ſyllabic combinations, each of the letters which compoſe the different ranks changes its place occaſionally with one of its own rank, and not with that of another; and in the caſe of the liquids, how, if any one of them occur in the nominative of a noun, it muſt remain unchanged in the oblique caſes; and if it occur in the preſent tenſe of a verb, it muſt remain unchanged in the futures; from whence the liquids have alſo got the name of *ἀμετάβολα*, *immutable*; likewiſe, in the caſe of the double conſonants, how each of them is occaſionally reſolved into the mute of which it is compoſed, and *σῖγμα*. All this might be ſhewn particularly, and at great length. But I return to the Σῖγμα.

In treating of the Greek characters, ſome diſtinguiſhed modern grammarians have not paid due attention to this letter. Gretser, the Jeſuit, in his arrangement of the conſonants, has aſſigned no place to it at all *. He does not even mention it as one of the ſemivowels, although it be evidently entitled to that diſtinction. Lancelot, author of the Port-Royal Grammar, at a loſs, it ſhould ſeem, what to do with it, has claſſed it, awkwardly enough, with the double conſonants. "Although "the Σῖγμα, ſays he, be the only one of its own ſet, we may "nevertheleſs join it with the double conſonants, not only be-"cauſe it forms one of their conſtituent parts, but alſo becauſe "they all reſemble it, by being ſibilant in the pronuncia-"tion †." Other grammarians, particularly Clenardus, Antesignanus and Hulewicz, have judged much better in taking the hint from the Greek writers already quoted, eſpecially

* *Inſtitutiones Ling. Gr. Ingoldſtadii*, 1605. 12mo.

† "Quoique le σ ſoit ſeul de ſa bande, nous pouvons neanmoins le joindre avec les "doubles, non ſeulement parce qu'il en fait partie, mais auſſi parce que dans leur pro-"nonciation elles ſont toutes ſifflantes comme lui." *Nouvelle Methode pour appendre facilement la Langue Greque. Paris*, 1754. 8vo.

eſpecially EMANUEL CHRYSOLORAS, and allowing the Σῖγμα to be a ſemivowel; but perceiving that it is neither a liquid, nor a double conſonant, nor a mute, they have called it *litera ſolitaria, et ſuæ poteſtatis*, vel *ſui juris*; the *ſolitary*, and the *abſolute* or *independent* letter; the letter which poſſeſſes a ſingular and independent power, nowiſe fettered by that relative analogy to which the other conſonants are obliged to ſubmit. That is to ſay, there has been a ſingular ſound obſerved to ſubſiſt in the Greek language, expreſſive of a great many varieties in the changes and inflections of words independent of certain other claſſes of changes and inflections; and that ſingular ſound has been denoted by the Σῖγμα. For it is certain, that languages were uſed previous to the invention of letters, though they muſt have been very rude in that early ſtate. But they would afterwards be much refined by thoſe very letters, the uſe of which muſt doubtleſs have ſuggeſted many eſſential improvements, which would not otherwiſe have been thought of.

Now, upon what grounds the Σῖγμα is entitled to an exemption or diſtinction, ſuch as I have mentioned, it may be worth while to examine. The inquiry will tend to ſhew the great uſe, and indeed abſolute neceſſity of ſuch a character in the alphabet of this moſt exquiſite of all languages.

Dr SAMUEL CLARKE, one of the moſt acute and ingenious of all the commentators, has, in a note upon the word πέλασσε, at the beginning of the thirteenth book of the Iliad, mentioned a probable reaſon, in his opinion, why the ancients held the Σῖγμα to be *ſuæ poteſtatis*. "Πέλασσε, ſays he, muſt " certainly be written with a double σ, becauſe the ſecond ſyl- " lable of πέλασε is ſhort. It may, however, (continues he), be " queſtioned, whether the more ancient Greeks made uſe of " that mode of writing. For when they called σ an arbitrary " letter, perhaps they meant, that whereas the letters ζ, ξ, ψ, " are neceſſarily double, and all the reſt of the conſonants " ſimple, σ alone has this peculiarity, that, in a great many

" places,

" places, eſpecially the aoriſts of verbs, it may be pronounced " either as a ſimple or a double letter *." This reaſon is ingenious; but, upon examining it narrowly, it does not appear to be ſatisfactory. Indeed Dr CLARKE himſelf does not ſeem quite ſatisfied with it, and offers it only as a conjecture. There is no doubt, however, of what this accompliſhed ſcholar has elſewhere † ſhewn, that the *penult* of the firſt aoriſt of ſuch a verb as πελάζω is ſhort, but that the poets, as HOMER has frequently done, may make it long, by doubling the σ, or rather by reſtoring the σ, which had been thrown away in the formation of the firſt future ‡. Nor is it improbable, that when the poems of HOMER were firſt committed to writing, the σ was ſet down ſingle, even when the verſe made it requiſite to pronounce it double. It happens, however, that this privilege of being occaſionally doubled, is not peculiar to the σ. We find, among the poets, other conſonants, mutes as well as liquids, frequently in the ſame ſituation. Thus,

Ὣς ἔφατ᾽· ἔΔΔεισεν δ᾽ ὁ γέρων καὶ ἐπείθετο μύθῳ ‖.

And

Τὸν καὶ ὑπέΔΔεισαν μάκαρες θεοὶ, ὐδέ τ᾽ ἔδησαν §.

Here

* πίλασσι.] " Ita jam ſcribendum, neceſſariò; quia πίλασι ſecundam corripit. Dubitari " tamen poteſt, utrumne Græci antiquiores iſto modo ſcripſerint. Nam quum σ, *ſuæ po-* " *teſtatis literam* dixerunt, haud ſcio an hoc ſibi voluerint; literas ζ, ξ, ψ, neceſſariò qui- " dem *duplices* eſſe; conſonantium reliquas omnes, *ſimplices;* unicam autem σ, iſtiuſmodi " eſſe, ut permultis in locis, ac *præcipue* in verborum Aoriſtis, *ſimplex dupléxve* ex æquo " pronunciari poſſit." *Ad Iliad.* ι′, 1.

† *Vide ad Iliad.* ά, 140. ζ′, 432.

‡ ACCORDING to the rule, which directs, that, in verbs not liquid, the firſt future ſhould ariſe from the preſent, by inſerting a σ before ω, πελάζω, which is the ſame with πελάδω, would have in the firſt future πελάζσω, or πελαδσω. But a ſpecial rule directs, that before ω we muſt, in the future, throw away τ, δ, θ, σ, which makes that tenſe of πελάζω to be πελάσω· hence the firſt aoriſt ἐπέλασα, to which reſtore the rejected σ, and it becomes ἐπέλασσα. *Vide* MOOR *Element. L. Gr.* p. 128.

‖ Iliad. ά, 33.

§ Ibid. ά, 406.

Here the δ is double in ἔδδεισεν and ὑπέδδεισαν, that ἐδδει may be a ſpondee, which it could not otherwiſe have been. We find the τ alſo frequently doubled, as ὅ, ττι *, inſtead of ὅ, τι. In which caſes, it is fully as probable, that in the early copies of the poems of HOMER, ſuch words were always written with a ſimple δ or τ, as that πέλασε, and others of the ſame ſort, were always written with a ſimple σ. Sometimes we find ρ, contrary to the rule by which it is ſaid to be always doubled after the ſyllabic augment, (as ῥίπτω, ἐῤῥιπτον), written ſingle by the poets: thus, ἐῤῥεζε, in the imperfect from ῥέζω, is written firſt ſingle, and then double, in the following verſes:

Ἄλλος δ' ἄλλῳ ἔρεζε θεῶν αἰειγενετάων †.
Οἴῃ δ' οὐκ ἐῤῥεζε Διὸς κούρῃ μεγάλοιο ‡.

In the firſt of theſe lines, δ' ἄλλῳ ἔ-- is a dactyl, in which the ῳ, one of the ſurd diphthongs, is ſhort before the firſt ſyllable of ἔρεζε, by a well known practice of the poets. Nay, we find, that even in the modern editions of HOMER, the liquid λ occurs written ſingle, when the verſe requires it to be pronounced double, which Dr CLARKE himſelf, with his uſual acuteneſs, has ſhewn to be the caſe in the exordium of the Iliad.

Ἡρώων, αὐτοὺς δ' ἑλώρια τεῦχε κύνεσσιν—

where ἑλώρια muſt be pronounced as if it were written ἑλλώρια, τοὺς δὲ being here a ſpondee. After all, it muſt be owned, that σ is much oftener doubled by the poets than any other conſonant. Indeed, no conſonant but itſelf admits of being doubled in the penult of the firſt aoriſts ‖.

THERE

* Iliad. ά, 294.

† Ibid. β', 400.

‡ *Iliad.* ί, 532. In ſome editions, ἔῤῥεζε is written ἔῤῥεξε in the firſt aoriſt, which anſwers the preſent purpoſe as well.

‖ In the middle voice it is the antepenult.

There are, however, ſeveral other grounds on which the claim of this letter to the appellation of *ſolitary* or *independent*, may be ſupported.

I. ΣΙΓΜΑ alone of all the conſonants employs its power in aſſiſting the mutes to make up the double letters. Thus, any one of the labial mutes π, or β, or φ, aſſiſted by σ, makes ψ· any one of the palatine mutes, κ, or γ, or χ, aſſiſted in the ſame manner, makes ξ· and any one of the dental mutes, τ, or δ, or ϑ, with the ſame help, makes ζ. In the caſe of ψ and ξ, this is evident from the mode of reſolving thoſe double letters in the inflections, eſpecially in the oblique caſes of nouns of the impariſyllabic declenſion. Thus, in the caſe of ψ, we perceive that λαίλαψ, *procella*, is the ſame with λαίλαπς, becauſe its genitive is λαίλαπος· that Ἄραψ, *Arabs*, is the ſame with Ἄραβς, becauſe its genitive is Ἄραβος· that κατῆλιψ, *ſcala*, is the ſame with κατῆλιφς, becauſe its genitive is κατήλιφος· and in the caſe of ξ, we perceive that κόραξ, *corvus*, is the ſame with κόρακς, becauſe its genitive is κόρακος· that φλόξ, *flamma*, is the ſame with φλόγς, becauſe its genitive is φλόγος· that ὄνυξ, *ungula*, is the ſame with ὄνυχς, becauſe its genitive is ὄνυχος. But the ſame analogy in the caſe of ζ is not ſo eaſily traced; and indeed the critics and grammarians, who have written in Greek, do not even aſſert that ζ is equivalent to δς, but to σδ *. Their reaſon ſeems to have been, that they never obſerved ζ reſolved into two ſimple conſonants, except in the Doric manner, as μελίσδω, inſtead of μελίζω, *modulor*; ὄσδω, inſtead of ὄζω, *oleo*. The learned Hulewicz even denies that ζ is a double letter; " becauſe, " (ſays he) it never is equivalent to two conſonants, like ξ and " ψ· for if ζ were a double conſonant, it would occur in the " termination of Greek words, as well as ξ and ψ, which it

 " never

* Vide Dionys. Hal. περὶ συνθ. ὀνομ. ιδ'. Dionys. Thracem apud Fabricium *in Biblioth. Gr.* Vol. VII. p. 28. Theod. Gazae *Grammat. fol.* 24. Theſe are followed by Clenardus, *&c.*

" never does *." But, in anſwer to this, it may be ſaid, that the argument againſt ζ being a double conſonant, becauſe it never terminates a word, cannot be admitted, as it is no where aſſerted, that to be a final letter is abſolutely neceſſary to the exiſtence of a double conſonant. But, granting this to be the caſe, ζ may in fact be ſaid, as well as ξ and ψ, to be a final letter, if the following circumſtances be properly attended to. It is obſerved by HULEWICZ himſelf, as well as other grammarians, that the dental mutes τ, δ, θ, are thrown away before σ. This happens evidently in the formation of the firſt futures of verbs: thus, τύπτω, *verbero*, not τύπτσω in the future, but τύπσω, which is written τύψω· ᾄδω, *cano*, not ᾄδσω, or ᾄζω, but ᾄσω· πλήθω, *impleo*, not πλήθσω nor πλήζω, but πλήσω. One reaſon for this ſeems to be, that if τς, or δς, or θς, had been permitted to remain in the firſt futures of verbs, they muſt have produced ζ, and this would have confounded the termination of thoſe futures with that of the preſent tenſes of a great many verbs in ζω, and thus have given riſe to a great ambiguity in the caſe of preſent and future tenſes; an inconvenience which the Greeks carefully avoided, and in the preſent inſtance the more willingly got rid of, becauſe the throwing away of τ, δ, θ, before σ, gratified an antipathy, which the Grecian ear, during the progreſs and refinement of their language, ſeems to have conceived againſt the combination of thoſe conſonants †; for it is evident, from the analogy of certain genitives which end in τος, δος and θος, that, in the early times of the Greek language, a great many nouns terminated in τς, δς and θς, which is the ſame with terminating in ζ· thus, λέβητς, or λεβηζ, by rejecting the τ before ς, becomes

* *Inſtitut. Gram.* p. 13.

† ANOTHER reaſon is, that, in many verbs, it would produce too great a concourſe of conſonants. See this illuſtrated above, p. 127. note ‡.

comes λέβης, *lebes*, but τ remains before ο in the genitive, λέβητος· λάμπαδς, or λάμπαζ, by rejecting the δ before ς, becomes λάμπας, *lampas*, in the genitive λάμπαδος· ὄρνιθς, or ὄρνιζ, by rejecting θ before ς, becomes ὄρνις, *avis*, in the genitive ὄρνιθος *. Farther, it may be inferred, that ζ is equivalent at leaſt to δς, from what happens in the formation of the ſecond future of ſuch verbs as ὄζω. For as τύπτω hath in the ſecond future τυπῶ, by throwing out the τ, which is the latter of the two conſonants, the former being the characteriſtic of the tenſe; ſo ὄζω (ὄδσω) hath ὀδῶ, by throwing out the σ, which is the latter of the two component conſonants in ζ, the δ being properly the characteriſtic of the tenſe. In the ſame manner, φράζω (φράδσω) hath φραδῶ, and ἕζω (ἕδσω) hath ἑδῶ. But that ζ was conſidered by the Greek writers as a double conſonant, may be clearly evinced from this, that, like the other two, ξ and ψ, it obliges a vowel immediately preceding it, though naturally ſhort, to be long by poſition, as is well known to all who have the ſmalleſt acquaintance with Greek proſody. It may be concluded then, that ζ is not only a double conſonant †, but is equivalent either to τς, or δς, or θς, though the general practice of the Greek writers was to reject τ, δ, θ immediately before σ, or to ſet down σ in moſt caſes where the general analogy requires ζ, and this, it ſhould ſeem, in order to produce a ſound more pleaſing to the

ear.

* Sometimes τ is thrown out betwixt κ and ς, after which the κς coming together muſt make ξ· thus, ἄνακτς, ἄνακς, ἄναξ, *rex*, Gen. ἄνακτος, where the ξ is reſolved into κς, and the τ is reſtored. See a moſt ingenious Diſſertation, aſcribed to the late learned Mr Jer. Markland, entitled, *De Græcorum Quintâ Declinatione Imparifyllabicâ, et inde formata Latinorum Tertia, Quæſtio Grammatica.* Extat cum Editione alterâ Euripidis Dramatis *Supplicium Mulierum*, quam *Londini* excudebat doctus typographus Gul. Bowyer, nuper defunctus, ejuſque diſcipulus J. Nichols. 1775.

† The other arguments adduced by Hulewicz, to prove that ζ is not a double conſonant, do not ſeem to have any weight. *Vid. Inſtitut. Gram. Gr. ubi ſupra.*

ear *. Σῖγμα, therefore, not only lends its aſſiſtance to the dental mutes, in order to form ζ, but even frequently occupies the place of ζ, the component mute being rejected.

II. ΣΙΓΜΑ is the only conſonant whoſe power is employed in the formation of the dative plural of the impariſyllabic declenſion; and this is done by interpoſing it immediately before ι of the dative ſingular: as, ῥήτωρ, *orator*, Dat. Sing. ῥήτορι, Dat. Plur. ῥήτορσι. So κόραξ (κόρακς), *corvus*, D. S. κόρακι, D. P. κόρακσι, which is κόραξι· φλόξ (φλόγς), *flamma*, D. S. φλόγι, D. P. φλόγσι, which is φλόξι· βήξ (βήχς), *tuſſis*, D. S. βήχι, D. P. βήχσι, which is βήξι. So alſo ὤψ (ὤπς), *oculus*, D. S. ὤπι, D. P. ὤπσι, which is ὤψι· Ἄραψ (Ἄραβς), *Arabs*, D. S. Ἄραβι, D. P. Ἄραβσι, which is Ἄραψι· κατῆλιψ (κατῆλιφς), *ſcala*, D. S. κατήλιφι, D. P. κατήλιφσι, which is κατήλιψι. Alſo, δαὶς (δαὶτς), *epulum*, D. S. δαιτὶ, D. P. not δαιτσὶ, nor δαιζὶ, but δαισὶ, becauſe τ, δ, θ, are thrown away before σ. λάμπας (λάμπαδς), *lucerna*, D. S. λάμπαδι, D. P. not λάμπαδσι, nor λάμπαζι, but λάμπασι. ὄρνις (ὄρνιθς), D. S. ὄρνιθι, D. P. not ὄρνιθσι, nor ὄρνιζι, but ὄρνισι †.

III. In

* It deſerves to be remarked, that one of the liquids, *viz.* ν, is alſo thrown away before ς of the nominative, and reſtored again in the genitive. Thus, μέλας, *niger*, for μέλανς, has, in the genitive, μέλανος. From ſome nominatives, both ν and τ are thrown away, and reſtored in the genitive: thus, γίγας for γίγαντς, *Gen.* γίγαντος· and they are again thrown away before σ in the dative plural, which is not γίγαντσι, but γίγασι. And when, in the preſents of verbs, ν and δ occur together, they are both thrown away before σω of the future: thus, κυλίνδω, *voluto*, κυλίσω, evidently for the ſake of a more pleaſing ſound. *Vid.* Moor *Elementa L. Gr.* p. 128.

With reſpect to what Hulewicz aſſerts about the final ς, in nouns of the third declenſion being changed into δ, θ, ν, τ, in the genitive, as ἔρις, *lis*, Gen. ἔριδος· ὄρνις, *avis*, Gen. ὄρνιθος· μέλας, *niger*, Gen. μέλανος· χάρις, *gratia*, Gen. χάριτος· this ariſes from his not having obſerved, with Mr Markland, that the full nominatives of thoſe words are, ἔριδς, ὄρνιθς, μέλανς, χάριτς· and that ς is not changed into the above mentioned conſonants, but that theſe having been thrown away in the nominative, *euphoniæ cauſâ*, are reſtored in the genitive, where that reaſon no longer takes place. *See above*, p. 130.

† In the dative plural, ν is alſo thrown out, as ποιμὴν, *paſtor*, D. S. ποιμένι, D. P. ποιμέσι. Other changes are made in this caſe in certain nouns *euphoniæ gratiâ*, but σ is always inſerted.

III. In the formation of the Greek verb, where a ſyſtem of the moſt beautiful kind may be traced, the ſingular or peculiar power of Σῖγμα is very conſpicuous.

1. It is *always* the characteriſtic of the firſt future, in verbs that are not liquid, a ſtation which it maintains without a rival. Thus, in pure verbs, τίω, *honoro*, τίσω, λύω, *ſolvo*, λύσω, τίμαω, *honoro*, τιμήσω, φίλεω, *amo*, φιλήσω, πλήροω, *impleo*, πληρώσω· in mute verbs, πλέκω, *plico*, πλέκσω, which is πλέξω, φεύγω, *fugio*, φεύγσω, which is φεύξω, βρέχω, *irrigo*, βρέχσω, which is βρέξω· alſo, βλέπω, *video*, βλέπσω, which is βλέψω, τρίβω, *tero*, τρίβσω, which is τρίψω, γράφω, *ſcribo*, γράφσω, which is γράψω· and ſo alſo in verbs ending in τω, δω and θω, in which the τ, δ, ϑ, are rejected before σω of the future, as has been already obſerved and exemplified *.

2. It is *never* the proper characteriſtic letter of the preſent tenſe, and therefore in that reſpect alſo it is ſingular. There are indeed a great many verbs which end in ζω· and as it has been ſaid that ζ is compoſed of δς, &c. it may be ſuppoſed that σ is here the characteriſtic of the preſent. But as in ſome verbs, ſuch as τύπτω and ῥίπτω, the former of the two conſonants, to wit π, is reckoned the characteriſtic; ſo in ſuch verbs as φράζω and νομίζω, δ perhaps is the characteriſtic, as if they were φράδσω and νομίδσω †. With reſpect to thoſe verbs which end in

* P. 130. It is to be remarked, that in pure and mute verbs, the σ, which is the characteriſtic of the firſt future active, is alſo that of the firſt aoriſt active, the firſt future, and firſt aoriſt middle; which it is needleſs to exemplify, as it is quite familiar, even to young ſcholars.

† In the Doric dialect, they are φράσδω and νομίσδω. Σ, however, is certainly the characteriſtic of their firſt future, where τ, δ, ϑ, are always thrown away. In this caſe, the propriety of throwing out the δ is apparent; for, if it were retained, φράζω would have in the firſt future φράζσω, which is the ſame with φράδσσω· and νομίζω would have νομιζσω, which is the ſame with νομίδσσω, where it is neceſſary alſo to throw away the σ which came from the preſent tenſe, on account of the σ which was aſſumed by the formation as the characteriſtic of the future, and therefore the futures actually are φράσω and νομίσω. See this hinted at above, p. 127. note ‡. See likewiſe, Moor *Elementa Ling. Gr.* p. 129.

in σσω in the present, in which a σ must be supposed to be the characteristic, this termination is plainly incident to a particular dialect, and those futures in ξω, which are said to arise from them, are actually derived from obsolete presents: thus, πράξω, the future, which is said to come from πράσσω, is evidently formed from the obsolete πράγω, which may be learned from the second future, which is πραγῶ. Indeed, πράσσω, and other verbs of that termination, cannot have a first future regularly formed, as σ, which is improperly adopted as the characteristic of the present, cannot also be the characteristic of the future in the same verbs. I may add, that the later Attics rejected that termination in σσω, and substituted ττω, saying πράττω, instead of πράσσω*. I must not omit observing too, that a few verbs occur which terminate in ψω and ξω, in the present, in which σ may be supposed the characteristic of that tense. But these seem to be futures substituted in place of certain obsolete presents from which they are derived, and whose meaning they have assumed. I know not that there are any more of them than the following, ἕψω, *coquo*; ὄδαξω, *mordeo*; ἀλέξω, *opitulor*; αὔξω, *augeo*. At any rate, so few exceptions, and those too of such a questionable shape, can have no effect against a general rule. The consequence, however, is, that such verbs, by having a σ in their present, must be defective; for there is no proper way of distinguishing their first future, the σ already being employed as the characteristic of the present.

3. ΣΙΓΜΑ *never* is the characteristic of liquid verbs, the liquid of the present always remaining in the future, and some other change being employed to mark this last tense, such as the shortening of the penult, if it be long, and the circumflection of the final ῶ †. The reason is, the analogy of the Greek tongue does not permit a liquid to precede σ, except, sometimes in the Doric dialect, as, ὄρω, *excito*,

* Vide Lennep *in Analogiam L. Gr.* p. 55, 56, &c.

† See Moor *Elementa L. Gr.* p. 128.

cito, ὄρσω· or for ſome ſpecial cauſe, as in the caſe of the prepoſition ἐν in compoſition, for example ἐνσπείρω, *inſero*, as will be ſhewn more particularly afterwards *.

IV. The ſingularity and independent nature of the σ is alſo very ſtriking, when we take a view of the ſtate in which the liquid ν is found, when it precedes the different letters of the alphabet †. This may be ſucceſsfully exemplified in the caſe of words compounded with the prepoſitions ἐν and σὺν· where we may remark one ſcheme of analogy for the vowels, one for each rank of the mutes, (which includes alſo the double conſonants, as theſe all begin with a mute,) and one for all of the liquids; but the ſolitary and abſolute Σῖγμα poſſeſſes a ſort of analogy peculiar to itſelf, different from all the reſt, though no leſs regular and beautiful.

1. EN and σὺν, in compoſition, remain before the vowels without any change; as, EN-Αλλάσσω, *immuto*; ΣΥΝ-Οίκεω, *una habito*, &c.

2. Before the *firſt* rank of the mutes, ν is changed into μ. Thus,

EM-	Πίπτω,	*incido.*	ΣΥΜ-	Πείθω,	*una perſuadeo.*
	Βάλλω,	*injicio.*		Βαίνω,	*congredior.*
	Φόρεω,	*importo.*		Φρονέω,	*conſentio.*

The reaſon is, that μ, being a labial liquid, coaleſces better than ν with the labial mutes π, β, φ, which may be obſerved in every ſuch union in the language ‡.

3. Before

* See below p. 137.

† The liquids are called immutable for the reaſon formerly given; but their immutability applies chiefly to their ſituation in the inflections of nouns and verbs; for ν is mutable in different parts of the analogy here remarked.

‡ Particularly in thoſe new preſents in ανω, which are formed from the ſecond future of other preſents by changing ω into ανω, and inſerting ν immediately after the vowel in the antepenult: thus, λείπω, λιπῶ, λιπάνω, λινπάνω, which is λιμπάνω· λήβω, λαβῶ, λαβάνω, λανβάνω, which is λαμβάνω. The ſame thing happens before ψ, which is compounded of any labial mute and σ, thus, EM-Ψύχω, *refrigero*. See p. 120. note †.

3. Before the *second* rank of the mutes, ν is changed into γ. Thus,

ΕΓ-	Κλείω,	*includo.*	ΣΥΓ-	Καλέω,	*convoco.*
	Γράφω,	*inscribo.*		Γελάω,	*simul rideo.*
	Χρίω,	*inungo.*		Χέω,	*confundo.*

The reason is, there being no palatine liquid, γ, the intermediate palatine mute, coalesces better than ν with the mutes of its own order; and this is a combination of very frequent occurrence in the Greek language *; the sound of the ν being at the same time retained and incorporated in the pronunciation with that of γ, though the former is thrown out in writing, to avoid the concourse of three, and sometimes of four consonants.

4. Before the *third* rank of the mutes, ν remains unchangeable; thus, ΕΝ-Τείνω, *intendo*, ΣΥΝ-Ταράσσω, *commoveo*, &c. The reason is, ν being a dental liquid easily coalesces with the dental mutes, without any change.

5. Before a liquid, ν passes into a liquid of the same kind with that which it precedes; thus,

ΕΛ-Λάμπω,	*illuceo.*	ΣΥΛ-Λέγω,	*colligo.*
ΕΜ-Μιγνύμι,	*immisceo.*	ΣΥΜ-Μάρπτω,	*corripio.*
ΕΝ-Ναίω,	*inhabito.*	ΣΥΝ-Νοέω,	*mecum reputo.*
ΕΡ-Ριγόω,	*inalgesco.*	ΣΥΡ-Ρέω,	*confluo.*

All this evidently was done *euphoniæ causâ*. But it is to be observed, that before verbs beginning with ρ, the preposition ἐν seldom passes into ἐρ, because, in that case, certain persons of the present tense of the compound verb would be confounded with certain persons of the imperfect tense of the simple verb; for in verbs beginning with ρ, the ρ is doubled after the syllabic augment; wherefore the euphony was generally here sacrificed, in order to

* Thus, from φαίνω, *ostendo*, we have in the perfect, not πέφανκα, but πέφαγκα. And in the new presents in ανω, formed from a second future, as already mentioned in the preceding note; ἐρεύγω, ἐρυγῶ, ἐρυγάνω, ἐρυνγάνω, which is ἐρυγγάνω· λήχω, λαχῶ, λαχάνω, λανχάνω, which is λαγχάνω. The same thing happens before ξ, which is compounded of any palatine mute and σ· thus, ΕΓ-Ξέω, *insculpo*.

to obtain a greater advantage, ἐνῤάπτω, *insuo*, for instance, being preferred to ἐῤῥάπτω *.

6. In the case of the solitary Σῖγμα, ν before σ, if a vowel follows the σ, becomes another σ· thus, ΣΥΣ-Σιτέω, *una cibum capio.* If a mute follows the σ, then, in the case of συν, the ν is struck out; but in the case of ἐν, it remains: thus,

σπ	ΣΥ-	ΣΠάω, *contrabo.*	EN-	ΣΠείρω, *insero.*
σβ		[No example †.]		[No example †.]
σφ		ΣΦάττω, *simul jugulo.*		ΣΦραγίζω, *signum imprimo.*

σκ	ΣΥ-	ΣΚάπτω, *simul fodio.*	EN-	ΣΚήπτω, *ingruo.*
σγ		[No example ‡.]		[No example ‡.]
σχ		ΣΧηματίζω, *conformo.*		ΣΧολάζω, *immoror.*

στ	ΣΥ-	ΣΤρατεύω, *simul milito.*	EN-	ΣΤρέφω, *intorqueo.*
σδ		Ζάω ‖, *una vivo.*		Ζέομαι ‖, *inferveo.*
σθ		[No example §.]		[No example §.]

 The

* The inconvenience which was thus prevented by ἐν remaining unchanged, may be perceived by declining the present tense of the compound verb, and the imperfect of the simple verb; thus,

Compound Verb: Present Tense.

S.	ἐῤῥάπτω,	ἐῤῥάπτεις,	ἐῤῥάπτει,
D.		ΕΡΡΑΠΤΕΤΟΝ,	ΕΡΡΑΠΤΕΤΟΝ,
P.	ΕΡΡΑΠΤΟΜΕΝ,	ΕΡΡΑΠΤΕΤΕ,	ἐῤῥάπτουσι.

Simple Verb: Imperfect Tense.

S.	ἔῤῥαπτον,	ἔῤῥαπτες,	ἔῤῥαπτε,
D.		ΕΡΡΑΠΤΕΤΟΝ,	ἐῤῥαπτέτην,
P.	ΕΡΡΑΠΤΟΜΕΝ,	ΕΡΡΑΠΤΕΤΕ,	ἔῤῥαπτον.

† This cannot be exemplified, because there is no Greek word which begins with σβ, except σβέννυμι, *extinguo*, with its verbals.

‡ There is no Greek word which begins with σγ.

‖ For ζ, which we shewed above to be equivalent to δς, is also, at least in the Doric dialect, equivalent to σδ.

§ There is no primitive Greek word which begins with σθ, except σθένω, *valeo.*

The reaſon why ν remains in the caſe of ἐν, is, that if ν were omitted, as in the caſe of συν, certain perſons of the preſent of the compound verb would be confounded with certain perſons of the imperfect tenſe of the ſimple verb, as in the caſe of ἐν becoming ἐῤ before ῥ, which has been already mentioned *.

V. *Laſtly*, The peculiar nature of Σῖγμα, and that which ſeems to have ſuggeſted its various functions in the ſtructure of the Greek tongue, ariſes from this, that it is the only letter which is ſibilant or hiſſing in the whole Greek alphabet. For ζ, which by ſome is conſidered as a ſibilant letter, is no farther ſo than the two other double conſonants ξ and ψ· and whatever ſibilation is obſerved in their ſound, they plainly derive from σ, which is half of their compoſition.

In what manner then the improvers of the Greek language availed themſelves of this ſingular letter, I have now endeavoured to ſhow. From the various uſes to which it has been applied, ſome have conſidered it as a ſervile letter; and from its hiſſing, and, as they thought, diſagreeable ſound, ſome of the ancient writers, notwithſtanding its great uſe in their language, conceived a violent diſlike at it. But this, with ſeveral other particulars relative to the ſame letter, I propoſe to conſider in a ſecond part of this Eſſay.

In the mean time, if the authority of names be deemed of any uſe in juſtifying inquiries of this nature, I may aſk with Quinctilian, " An ideo minor eſt M. Tullius orator, quod " idem artis hujus diligentiſſimus fuit, et in filio (ut in epiſto- " lis apparet) recte loquendi uſquequaque aſper quoque exactor? " Aut vim C. Cæsaris fregerunt editi *de analogiâ* libri? Aut " ideo minus Messala nitidus, quia quoſdam totos libellos non " de verbis modo ſingulis, ſed etiam literis dedit †?"

If

* This will appear evident, by declining the preſent tenſe of a compound verb, with the ν thrown out, as ἐσπείρω, &c. and the imperfect tenſe of the ſimple verb, as ἔσπειρον, &c.

† *Inſtitut. Orat. Lib.* I. *Cap.* 7. " Vileſcit tibi hic ſermo. Itane? Scilicet Mureto " et Lipsio indignum decurrere Grammaticum hoc æquor, quod tot olim Senatores " imò

If a farther apology ſtill be requiſite for a long diſcourſe upon a ſubject ſeemingly ſo frivolous as a ſingle letter, I might deny that the ſubject is frivolous. Nothing, it might be ſaid, is frivolous, which has for its object an inveſtigation into the moſt minute cauſes of the cultivation of that faculty, which, next to our intellectual powers, is the moſt important the human ſpecies enjoys; without which indeed our intellectual powers themſelves would, in a great meaſure, be deſtitute of the means of improvement, but with the elegant and correct uſe of which, elegance and correctneſs in ſcience muſt ever go hand in hand. I may add, that it is an exerciſe ſurely of no illiberal ſort, to explore, and to produce to view, thoſe marks of minute attention which the moſt accompliſhed people in the world beſtowed upon the conſtituent elements of their language, and which contributed to render that language of all others the nobleſt in every reſpect, and to all thoſe who attain to a knowledge of it, the object of enthuſiaſtic admiration.

PART II.

ALTHOUGH the letter *Σῖγμα* be of ſuch eſſential uſe in the inflections of the Greek language, as I have endeavoured to explain, yet when it happens, either in proſe or in poetry, to be frequently introduced without neceſſity, the re-

S 2 peated

" imò addo, Imperatores. Messala orator, è clariſſimâ Corvorum gente, non librum " integrum De unicâ literâ S compoſuit? et cum laude quidem nominis ſui, adeò ſine " fraude. Claudius Imperator, quantâ curâ, et pænè dicam ambitione, tres novas " literas invexit, iiſque Romanam linguam auxit? non aliâ, quam ſi totidem regnis im- " perii fines. Jam Cæsar ille Julius *De Analogiâ*, id eſt de infimis Grammaticorum " ineptiis, binos libros conſcripſit: et triumphales illas epulas variare et interſtinguere " non erubuit ſcholicâ iſtâ dape." Lipsius *de recta pronunc. Ling. Lat.*

peated ſibilation thereby occaſioned is undoubtedly very diſagreeable to the ear. Of this, a noted paſſage in the *Medea* of EURIPIDES, which has been ſeverely cenſured by ſome critics, is a ſufficient proof.

> Ἔσωσά σ᾽, ὡς ἴσασιν Ἑλλήνων ὅσοι
> Ταυτὸν συνεισέβησαν Ἀργῷον σκάφος *.

The poet, however, had not attended to this circumſtance, otherwiſe he would have avoided ſuch an offenſive tautology. CICERO, from inadvertence of a ſimilar ſort, has begun his *Topica* with the following ſentence: "Majores nos res ſcribere "ingreſſos, C. TREBATI, et iis libris, quos brevi tempore ſatis "multos edidimus, digniores, e curſu ipſo revocavit voluntas "tua." Several ſuch paſſages might be produced from the beſt authors, both Greek and Latin, if it were worth while to collect them.

IT is remarkable, that in the Engliſh tongue, where almoſt no inflection takes place, and conſequently where the S has no peculiar duty to diſcharge, that letter is of more frequent occurrence than in any other language, and occaſions, eſpecially in the ears of foreigners, a conſtant and diſagreeable hiſſing †. Such a language would have been conſidered as harſh and barbarous in an extreme degree, by thoſe ancient authors who were offended

* Verſe 477.

† "S (ſays JOHNSON) has in Engliſh the ſame hiſſing ſound as in other languages, and "unhappily prevails in ſo many of our words, that it produces in the ear of a foreigner "a continued ſibilation." *Dict. Letter* S. ADDISON too had obſerved, "That a change "has happened in our language, by the abbreviation of ſeveral words that are terminated in *eth*, by ſubſtituting an S in the room of the laſt ſyllable, as in *drowns*, *walks*, "*arrives*, and innumerable other words, which, in the pronunciation of our forefathers, "were *drowneth*, *walketh*, *arriveth*. This (adds he) hath wonderfully multiplied a let"ter which was before too frequent in the Engliſh tongue, and added to that hiſſing in "our language, which is taken ſo much notice of by foreigners." *Spectator*, No. 135.

offended even with a moderate uſe of *Σίγμα* in the Greek. DIONYSIUS of Halicarnaſſus, in particular, has ſaid, that "the "*Σίγμα* is harſh and unpleaſant, and when unneceſſarily re- "peated, exceedingly offenſive; for its hiſſing ſeems to be con- "nected with what is wild and irrational, rather than with the "voice of rational beings. Wherefore (continues he) ſome "ancient authors uſed it but ſeldom, and with caution, and "others compoſed whole odes without this letter *."

To condemn, however, the uſe of this letter on all occaſions, either becauſe its ſound reſembles the hiſſing of a ſerpent, or perhaps becauſe the ſound of hiſſing has been an uſual mode of expreſſing diſlike in different ages and nations of the world, would be a faſtidious and hypercritical method of judging. HERODOTUS, the ſweeteſt of all proſe writers, furniſhes a variety of ſuch periods as the following: Κροκοδείλυς δὲ Ιωνες ὠνόμασαν, εἰκάζοντες αὐτῶν τὰ εἴδεα τοῖσι παρὰ σφίσι γινομένοισι κροκοδείλοισι τοῖσι ἐν τῇσι αἱμασιῇσι †. From this we may infer, that the Ionic Greeks were not very much diſguſted even with a frequent repetition of the *Σίγμα*. But ſuch a paſſage, not only on account of the frequent occurrence of *Σίγμα*, but alſo of Ιῶτα, would have been intolerable to an Attic ear, which ſeems to have had a particular averſion to the repeated uſe of the letter in queſtion, and induced that refined people to prefer the double ττ to the double σσ in a great many of their words; as when they ſaid *θάλαττα* inſtead of *θάλασσα*, *πράττω* inſtead of *πράσσω*, and even *συρίττω* inſtead of *συρίσσω*, *to hiſs*. The propriety of ſuch a change, however, ſeems to have been the ſubject of diſpute among ſome of the ancient writers, and gave occaſion to a *jeu d'eſprit* of LUCIAN, which has deſcended to our times,

* Ἄχαρι δὲ καὶ ἀηδὲς τὸ σ, καὶ ἐν πλεονάσειε, σφόδρα λυπεῖ· θηριώδυς γὰρ καὶ ἀλόγυ μᾶλλον ἢ λογικῆς ἐφάπτεσθαι δοκεῖ φωνῆς ὁ συριγμός· τῶν γῦν παλαιῶν σπανίως ἐχρῶντό τινες αὐτῷ καὶ πεφυλαγμένως· εἰσὶ δὲ οἱ ἀσίγμυς ᾠδὰς ὅλας ἐποίυν· Περὶ συνθ. Ὀνομάτ. *Edit.* REISKII, Vol. V. p. 80.

† Book II. chap. 69.

times, under the title of Δίκη Φωνηέντων· *The judgment of the Vowels;* where that exquiſite author, with his uſual talent for ludicrous compoſition, has introduced the letter Σῖγμα arraigning the letter Ταῦ before the tribunal of the ſeven Vowels, and calling out loudly for juſtice againſt the encroachments made upon him by this atrocious delinquent. It is ſcarcely poſſible to render the performance intelligible to a mere Engliſh reader, as the ridicule chiefly ariſes from the ſolemnity with which an unimportant ſubſtitution of certain Greek letters in the place of others, is treated. But it may be tranſlated in ſuch a manner as to amuſe this learned audience, and ſerve perhaps as ſome ſort of atonement for the treſpaſs committed againſt their patience, in the former part of a dry grammatical diſcuſſion. The humour of the piece is heightened, by its being a very ſucceſsful and well ſupported imitation of an ancient pleading.

LUCIAN's *Judgment of the Vowels.*

" IN the Archonſhip of ARISTARCHUS of Phalerum *, on the
" 7th of November †, the letter Σῖγμα commenced a proſe-
" cution againſt the letter Ταῦ, at the bar of the ſeven
" Vowels, for violent diſtraining of goods, alleging that he
" was plundered of all thoſe words uſually pronounced with
" a double Ταῦ.

" YE

* THE learned CORSINI, merely upon the authority of this paſſage of LUCIAN, has inſerted in his *Faſti Attici,* the name of ARISTARCHUS *Phalereus,* as *Archon Eponymus* at Athens, in the 1ſt year of the CCXXII. Olympiad, and of the Chriſtian æra, 109. It may be ſuppoſed, however, that, in a ludicrous compoſition of this ſort, LUCIAN would not mind an adherence to the truth of chronology, but might pitch upon an Archon on this occaſion called ARISTARCHUS, in alluſion to the famous grammarian of that name who was born in Samothracia, and flouriſhed at Alexandria about the CLVI. Olympiad; and who was ſo eminent in his art, that the name ARISTARCHUS became ſynonymous with the word *Critic.* See CORSINI *Faſti Attici, Tom.* II. p. 104. and *Tom.* IV. p. 165.

† SCALIGER and others ſuppoſe Πυανεψιῶν to correſpond to the month of October. I have preferred the opinion of PETAU and CORSINI, who make it to agree with November.

On

" Ye Vowels, before whose tribunal I stand, as long as " the injuries I received from this Ταῦ here were but of a tri- " vial nature, whilst he abused my property, and encroached " upon me where he had no just right or title, I bore the loss " without repining; and out of the deference which you know " I observe both to you and the other syllables, I lent a deaf " ear to certain insinuations which were circulated to his dis- " credit. But since he proceeds to such a pitch of avarice and " folly, as to be constantly adding more heinous acts of vio- " lence to those which, with a reluctant silence, I used to suffer, " I am forced to arraign him before YOU, who are well ac- " quainted with the disposition of us both. And I am under " no small apprehension, on account of this expulsion to which " I am exposed; for while he is continually adding something " more violent to what he has already perpetrated, he will soon " thrust me completely out of my own province, so that by be- " having thus tamely, I shall run the risk of being no longer " accounted a *letter*, and all of us shall have some reason to be " alarmed *.

" It is therefore expedient, that not only YOU who at pre- " sent sit in judgment, but likewise the other Letters, should " be upon your guard against this daring attempt. For if any " one who has amind shall be permitted to quit the post as- " signed

On the 7th of Πυανεψιῶν, were celebrated at Athens the festivals called Πυανέψια and Ὀσχοφόρια. See Corsini *Fasti Attici*, *Vol.* I. p. 63. and *Vol.* II. p. 383. Also, Potter's *Archæol.* *Vol.* I. p. 418. & 423.

* In the Greek, the last member of this sentence is, ἐν ἴσῳ δὲ κεῖσθαι τοῦ φόβου· to which Bourdelotius proposes to add, τὰ λοιπὰ γράμματα· which he found on the margin of one MS. *and the rest of the letters be in the same alarming situation.* Instead of τοῦ φόβου, the celebrated Hemsterhuis seems disposed to read τῷ [i. e. τινι] ψόφῳ, and to render the sentence as follows: *Ita ut parum absit, quin, si quietus injuriam ultra feram, e numero literarum expungar, neque alio sim loco, quam sonus aliquis, vel, sibilus.* I have no doubt that the phrase, as it is in the printed books, came from the pen of Lucian, ἐν ἴσῳ δὲ κεῖσθαι τοῦ φόβου, *i. e.* δὲ τι τοῦ φόβου κεῖσθαι ἡμῖν ἐν ἴσῳ, *and all of us have some reason to be alarmed.* This meaning is confirmed by what immediately follows.

" ſigned to him, and violently to intrude himſelf into that of " another, and this too by *your* connivance, without whoſe aid " nothing is written to any purpoſe, I cannot ſee how the ſe- " veral ranks will maintain their juſt rights, according to the " original arrangement. But I truſt that neither you will ar- " rive at ſuch a pitch of negligence and ſloth as to permit the " perpetration of injuſtice, nor, though *you* ſhould decline all " participation in this ſtruggle, muſt I, who am the ſufferer, " abandon my plea.

" WOULD to heaven! the audacity of certain other letters had " received a check the inſtant they began to violate the law, " and then Λάμβδα would not at this day have been at daggers- " drawing with ʽΡῶ, diſputing whether a *pumice-ſtone* ſhould be " written κισσήρις or κισσήλις, or a *headach* ſhould be κεφαλαλγία " or κεφαλαργία· nor would Γάμμα have been perpetually " wrangling, and even frequently upon the point of coming " to blows, with Κάππα, in the fuller's ſhop, inſiſting that *the* " *flocks of wool ſhorn off by the fuller*, ſhould be γνάφαλα and not " κνάφαλα· and the ſame Γάμμα would have no longer con- " tended with Λάμβδα, by taking away from him, and indeed " totally robbing him of, the word *hardly*, calling it μόγις in- " ſtead of μόλις· and the reſt of the letters would have aban- " doned every attempt to introduce an illicit confuſion. For it " is fair that each ſhould abide by his appointed ſtation; as " every tranſgreſſion of the bounds preſcribed marks the cha- " racter of a ſubverter of juſtice.

" WHOEVER at firſt eſtabliſhed theſe laws for us, whether it " was CADMUS the iſlander *, or PALAMEDES the ſon of NAU- " PLIUS,—(ſome aſcribe this important charge to SIMONIDES) " —not only determined who ſhould be firſt and who ſecond

" in

* See above, p. 118. note †. The famous CADMUS, ſon of AGENOR, is here called ὁ νησιώτης, from his connection with Tyre, according to ancient authors originally built in an Iſland, which ALEXANDER is ſaid afterwards to have joined to the Continent. See the notes of DU SOUL and HEMSTERHUIS, in the 4to Edit. of LUCIAN's *Works. Tom.* I. p. 87. *Amſt.* 1743.

" in that order wherein the ſeats of precedence are fixed, but
" alſo fully underſtood the qualities and powers which belong
" to each of us. And on you, ye Judges, he hath conferred
" the larger portion of honour, inaſmuch as you are capable
" of expreſſing a ſound by yourſelves; on the ſemivowels, the
" next ſhare to yours, becauſe they require a ſmall degree of
" your aſſiſtance, in order to be diſtinctly heard; and he hath
" allotted the leaſt of all to ſome who, by themſelves, poſſeſs
" no ſort of ſound whatſoever *. Wherefore, it is the province
" of you Vowels to be the guardians of theſe laws.

" But this Ταῦ, (for I have not a more opprobrious appel-
" lation for him than his own name †) who, unleſs, by Jupiter!
" two of yourſelves, I mean Ἄλφα and Υ, excellent both, and
" ſeemly to behold, had come propitious to his aid, would not
" even have been heard,—this very culprit dares to injure me
" in a more atrocious manner than ever any other of the letters,
" by expelling me from my native nouns and verbs, at the
" ſame time chaſing ‡ me away from conjunctions and prepo-
" ſitions, inſomuch that I am no longer able to endure his ex-
" ceſſive rapacity. But it is now time to ſtate whence, and
" from what circumſtances, theſe outrages originated.

" I once was ſojourning at Cybelum, an agreeable enough
" little town, a colony, as is reported, of Athenians, and took
" along with me the beſt of my neighbours, the robuſt Ῥῶ.
" I lodged at the houſe of a certain comic poet, whoſe name
" was Lysimachus, by extraction evidently a Bœotian, but
" who was ambitious of paſſing for a native of the very centre
" of Attica. While I remained in the houſe of this landlord,
" I detected the avarice of this ſame Ταῦ. As long as, by de-
" priving me of my congenial friends, he ſeized only on a few

* See Aristotle's definition of a Vowel, a Semivowel and a Mute, p. 123.

† See below, p. 149.

‡ I have adopted the reading propoſed by Hemsterhuis, *viz.* ἀπιλάσαι and ἰκδιώξαι.

" of them, ſo as, for inſtance, to call *forty* τετταράκοντα inſtead
" of τεσσαράκοντα, I imagined it to be a common practice among
" the letters who were there educated together. And even
" while he claimed a right to force *to day* into his train by the
" name of τήμερον inſtead of σήμερον, and uſed the ſame freedom
" with other words of that kind, as if they had been his own
" property, I tolerated what I heard with ſome degree of pa-
" tience, and was not very violently provoked upon the occa-
" ſion. But when, after beginning in this manner, he had the
" impudence to metamorphoſe the word ſignifying *ſteel* from
" κασσίτερον into καττίτερον, and to call *cobler's leather* κάττυμα
" inſtead of κάσσυμα, and *pitch* πίττα in place of πίσσα; and,
" in ſhort, having diveſted himſelf of all ſenſe of ſhame, to
" inſult the name of *Queen*, by pronouncing that βασίλιττα
" which ought to have been βασίλισσα, I got into a moſt furi-
" ous paroxyſm of rage, being apprehenſive that ſome one, in
" proceſs of time, might venture to ſay τῦκα inſtead of σῦκα,
" and ſo not leave me ſo much as a ſingle *fig*.—I beſeech
" you, in the name of Jove! to bear with this juſt indigna-
" tion, when you reflect that my ſpirit is ſo much depreſſed,
" and that I have none who are ready to help me; for when
" the queſtion is about depriving me of words that have been
" my wonted and familiar companions, ſurely no trivial and
" vulgar objects are at ſtake. Having torn my prattling κίσσα,
" my favourite *magpie*, as it were out of my boſom, he calls it
" his κίττα, and, in defiance of the command of ARISTAR-
" CHUS, he hath ſeized on my *ringdove*, which he calls φάττα,
" on my *ducks*, ſtyling them νῆτται, and my *ouſels*, to which he
" gives the odious name of κόττυφοι. He hath borne off whole
" hives of my *bees*, calling them μελίτται inſtead of μελίσσαι.
" Nay, having made an incurſion into the Attic territory, he
" hath even carried away, in the moſt outragious manner, the
" region of bees, mount *Hymettus* itſelf, and that too before
" your own eyes and thoſe of the other ſyllables. But why

" do

"do I mention ſuch circumſtances as theſe? He has baniſhed "me entirely out of *Theſſaly*, to which he inſiſts upon giving "the name of *Thettaly*, and he has claimed an excluſive right "to the very *ſea*, which he calls θάλαττα inſtead of θάλασσα. "Nor does he even abſtain from the *beets* in my garden, inſo-"much that he has not, I may ſay, left me a ſingle πάσσαλος, "or *little pole*, which I can call my own. But you yourſelves "can bear me witneſs what a patient *character* I am; for I "never ſo much as found fault with ζ, when he ſtole my pre-"cious σμαράγδος*, or *emerald*, from me, and thruſt me out of "the city of *Smyrna*; nor with ξ, when he violated every ſti-"pulation †, and even has THUCYDIDES the hiſtorian as the "abettor of his guilt. As to my next neighbour Ῥῶ, it was "but an act of humanity in me to forgive *him*, when, in the "*delirium* of a diſeaſe, he planted my *myrtles* in his own garden, "as if they had been called μυῤῥίναι, and not μυρσίναι, and, "under the preſſure of a deep melancholy, ſtruck me a blow "on the cheek. Such is the patient natural temper with which "I am endowed.

"BUT the violent diſpoſition of this Ταῦ will be ſtill more "apparent, when we reflect, that he has alſo injured, not only "Δέλτα, Θῆτα and Ζῆτα, but almoſt every one of the other "letters. Call in the plaintiffs. Hear, O ye Judges, what "Δέλτα has to ſay.—Δ. He hath bereaved me of my faculty of "*perſeverance*, requiring, in the face of all law, that it ſhall be "called ἐντελέχεια inſtead of ἐνδελέχεια.—Liſten, I beſeech you "to the wailing of Θῆτα, who is tearing his hair in anguiſh for "the loſs of his *gourd*, which has been changed from κολοκύνθη "into κολοκύντη; and to Ζῆτα, complaining that he no longer "hears the *muſic of the pipe* nor the *ſound of the trumpet*, συρίζειν

 "and

* WHICH is ſometimes written ζμαράγδος, as Σμύρνα is written Ζμύρνα. See the annotation of HEMSTERHUSIUS.

† σύνθηκην,—which THUCYDIDES writes ξύνθηκην, and ſo in many other words, uſing ξ for σ, as is well known.

" and σαλπίζειν being now ſupplanted by συρίττειν and σαλπίττειν· " and that he is not allowed even to *grumble*, the proper word " γρύζειν being now no more. Who could have patience to en- " dure ſuch indignities? or what puniſhment is adequate to " the demerits of this moſt execrable Ταῦ?

" But, in ſhort, he is not only injurious to his kindred tribe " of letters, but has already begun to encroach upon the hu- " man race, in ſuch a manner that he permits them not to " make a proper uſe of their tongues. *Apropos* of tongues, " which this mention of human affairs has introduced, it " brings to mind how the miſcreant has uſurped my province " here too, by metamorphoſing γλῶσσα, *a tongue*, into γλῶττα. " O thou villanous Ταῦ! thou very bane of all tongues!— " But to return from this digreſſion to the defence of men, " whom he has ſo groſsly injured. He attempts to torture their " voice, and bind it with chains. When one perſon beholds " a beautiful object, and wiſhes to ſtyle it κάλον, *fair*, up comes " this Ταῦ, and moſt impudently obliges him to call it τάλον; " ſuch is the violence of his claim to be at the head of every " thing! When another is ſpeaking of a *vine-branch* by the " appellation of κλῆμα, he himſelf being τλῆμον, *a wretch*, " makes the poor word wretched too, by calling it τλῆμα. " Nor are his injuries confined to vulgar men; he even forms " a plot againſt that tremendous Monarch, to whom the earth " and the ſea, in a ſupernatural manner, are reported to have " yielded *; and inſtead of giving him his proper name Κῦρος, " Cyrus, he ſpeaks of him by the appellation of Τῦρος, as if " he were a *cheeſe*.

" Such then are the ways in which he injures men in their " ſpeech. But how does he ſtill more materially injure them? " They

* Lucian ſeems here to allude to the magnificence of the oriental ſtyle. Xenophon, in the *Anabaſis*, relates, that Cyrus the younger, with his army, paſſed the Euphrates on foot, which had never been forded in that manner before, and adds—ἐδόκει θεῖον εἶναι, καὶ σαφῶς ὑποχωρῆσαι τὸν ποταμὸν Κύρῳ ὡς βασιλεύσοντι. Lib. I. See the annotation of Hemsterhuis.

" They lament and deplore their hard fate, and often execrate " CADMUS for introducing this *Ταῦ* among the number of the " letters. For they ſay that tyrants, taking the hint from the " appearance, and imitating the form, of this letter, did fa- " bricate gibbets to hang men upon; and hence this moſt " miſchievous contrivance obtained its odious name *. For all " theſe crimes, how many deaths do you ſuppoſe this *Ταῦ* de- " ſerves? For my own part, I reckon the only puniſhment " adequate to his guilt would be to hang him upon a machine " of his own ſhape; for it was owing to him that there was ever " ſuch a thing in the world as the figure or the name of a " gallows."

THUS far LUCIAN; and it muſt be owned that the ludicrous manner was the moſt proper that could be employed in treating ſuch a ſubject. LIPSIUS, in his Dialogue *de rectâ pronunciatione Latinæ linguæ*, has obſerved, " That many attack the reputation " of the letter S, and even form a deſign againſt its life."— *famam ejus multi petunt, imo vitam.*—And he adds an enumeration of thoſe enemies. " PINDAR (ſays he) reproaches it, and " calls it *κίβδηλον*, *ſpurious*, and, out of hatred to it, is ſaid to " have compoſed verſes without its aſſiſtance. DIONYSIUS the " rhetorician, in exalting the Ῥῶ, undervalues this letter, and " brands it with the vile epithet of *θηριώδη*, *ſavage*. All the " Attics deteſt it, and generally have ſubſtituted *Ταῦ* in its " room. Latin authors ſeem to join in the conſpiracy; and, " among men of rank, MESSALA ſays it is not even a *letter*, " but only a *hiſs*. Among teachers, QUINCTILIAN pronounces " it to be a rough letter, and harſh in the combination of " words. Nay, even the ancient writers rejected it, in imita- " tion

* " VERISISSIMA vocis *σταυρὸς* originatio: *ταῦ*, *ταυηρὸς*, hoc eſt in modum *ταῦ* efformatus: et per contractionem *ταυρὸς*· et præpoſito ſigma ut fieri ſolet, *σταυρὸς*." MENAGIUS.

" tion of the Attics; and their method was, to uſe *mertare* and " *pultare* inſtead of *merſare* and *pulſare*, juſt as Ennius uſed " *adgrettus fari* inſtead of *aggreſſus fari*. The poets alſo have " taken a ſide; and, in their verſe, this letter, when a conſo-" nant follows, is commonly expunged. Thus,—*vitâ illâ dig-" nu' locoque.* And—*omnibu' princeps*: And in the Plays of " Plautus and Terence, examples frequently occur."

Against all this hoſtility which has been declared againſt the S, Lipsius undertakes its defence. The paſſage is curious; but being too long for a quotation, I refer to the work itſelf. The elegant Muretus is a ſpeaker in the Dialogue, and on him Lipsius devolves the taſk of vindicating his favourite letter; but, like other ſtrenuous advocates, he appears to carry his zeal for his client too far *.

There

* I shall tranſlate ſome excerpts from it in this note: In anſwer to Pindar's charge, Muretus inſiſts, " That Σίγμα has a genuine ſound, and every other mark of a genuine " letter." And with reſpect to the epithet of θηριώδη, given to it by the Halicarnaſſian, if the meaning be, that Σ denotes a ſound ſimilar to the hiſſing of ſerpents, this he thinks a very ſtrange objection: " Why then (ſays he) don't you deſpiſe the letter R, becauſe " it is expreſſive of the noiſe of dogs? M, becauſe that of oxen? B, becauſe that of " ſheep? For dogs *ſnarl*, oxen *low*, or utter a noiſe which in Greek is *μυκάω*, and in " Latin *mugire*, and ſheep *bleat*. But ſince you call this hiſſing of ſerpents deteſtable, " tell me, what ſhall you think of winds, of trees, of men? You will not deny that they " *whiſper*, and that moſt agreeably.—The ancient inventors of names, as if nature had " been their guide, denoted the moſt delightful of all objects by this letter. Look up to " the heaven, there you behold the *ſun*, the *ſtars*. Look down to the earth, among the " things that are *ſweet*, you find *ſeſame* and *ſugar*; among the charms of love, *whiſpers* " and *kiſſes*; and among the joys of life, *ſleep*, *ſafety*, *ſoundneſs*." And a little after he adds, " The Attics, you ſay, deſpiſed it. Why ſhould I be ſurpriſed that the moſt faſti-" dious of mortals did ſo? But the Lacedæmonians and Thebans were of a different opi-" nion. At this very day, the robuſt inhabitants of Germany delight in this ſtrong ſi-" bilating ſound, which (let not my Lipsius be offended) is avoided by you, the delicate " inhabitants of the Netherlands. You are in the wrong. But I do not point out your " error, becauſe Lucian has already pleaded and diſcuſſed the cauſe before the tribunal " of the Vowels." The ſpeaker next proceeds to anſwer the objections of Messala and Quinctilian, and then ſhews that the ancient writers made very frequent uſe of this letter, inſomuch that their inſertion or ſubſtitution of it ſeemed, in his opinion, to ſavour of affectation; and, after producing a great many inſtances of this, and accuſing thoſe

poets

THERE seems, however, to be no good reason either for applauding or condemning the sound of this letter in the extreme. Passages have been already quoted from EURIPIDES and CICERO, which, if read with attention, must convince every one, that its frequent recurrence is disagreeable to the ear, though that circumstance seems to have escaped the notice of the authors themselves in composing those sentences. But MILTON has, with manifest design, availed himself of the discordant sound produced by such a repetition, and that with powerful effect, in the following verses, where SATAN, when described as having arrived at Pandæmonium, and in a boasting manner related his success against Man, is received by his infernal audience with a general hiss.

So

poets of ignorance who despise this letter, he puts the question, "Have not I now said "enough, LIPSIUS, about the fondness and respect which the ancients had for this let- "ter?—Yes, quite enough."

THIS Dialogue betwixt LIPSIUS and MURETUS, is dedicated to the renowned Sir PHILIP SIDNEY. The scene is laid on the Quirinal, in a garden belonging to the splendid HIPPOLYTUS of Este, the patron of MURETUS. LIPSIUS represents himself as a young man on his travels at Rome, possessing an ardent desire of knowledge. Having paid a visit at the apartments occupied by MURETUS in the house of his patron, he was shewed into the garden, where he found that accomplished scholar so deeply engaged in reading, as for some time to pay no attention to the approach of the stranger. The book he had in his hand happened to be a work of LIPSIUS himself, entitled *Varia*, which had been lately published at Antwerp. A pleasing description of this interview is given by LIPSIUS in the commencement of the Dialogue, "*Cubiculum ejus cum pulsassem,*" &c. They afterwards enter upon the proper subject of the piece, in which MURETUS is represented as the principal speaker. But the style, in point of elegance, is far inferior to what MURETUS would have really made use of. The work indeed is confessedly the composition of LIPSIUS, whose Latinity, though he was one of the ablest critics of the sixteenth century, has with justice been censured. His merit was such, however, that even his style procured a numerous tribe of imitators. But no modern writer of Latin has surpassed the elegance of MURETUS. His orations in particular, in point of ease and fluency of expression, may perhaps even vie with those of CICERO. It must give every scholar pleasure to hear, that the celebrated RUHNKENIUS of Leyden, is at present engaged in preparing for the press a new and complete edition of the works of MURETUS. "Il faut "(says BAYLE) bien aimer les mauvais modeles quand on est capable de préférer le "style de LIPSE à celui de PAUL MANUCE, ou à celui de MURET; un style qui va par "sauts, et par bonds, herissé de pointes et d'ellipses, à un style bien lié et coulant, et qui "develope toute la pensée." *Dict. Artic.* LIPSE, *Not.* [L.]

So having ſaid, awhile he ſtood expecting
Their univerſal ſhout and high applauſe
To fill his ear: when contrary he hears
On all ſides from innumerable tongues
A diſmal univerſal hiſs, the ſound
Of public ſcorn. ——
He would have ſpoke,
But hiſs for hiſs returned with forked tongue
To forked tongue: for now were all transform'd
Alike, to ſerpents all, as acceſſories
To his bold riot: dreadful was the din
Of hiſſing through the hall; thick ſwarming now
With complicated monſters, head and tail
Scorpion and aſp, and amphiſbœna dire,
Ceraſtes horn'd, hydrus and elops drear
And dipſas *.

On the other hand, it is certain, that a judicious introduction of this letter produces, on many occaſions, a very pleaſing effect; ſuch as may be perceived from the two concluding words of the following verſes of the ſame poet. Our firſt parents are the ſubject.

——He on his ſide
Leaning half-raiſed, with looks of cordial love
Hung over her enamoured; and beheld
Beauty, which whether waking or aſleep
Shot forth peculiar graces; then with voice
Mild, as when Zephyrus on Flora breathes,
Her hand, ſoft touching, whiſper'd thus †.

Theocritus, in the very beginning of his firſt Idyllium, repreſents Thyrsis, a ſhepherd, addreſſing a goatherd in the following manner: " Goatherd, this pine, which is beſide " the

* Par. Loſt, Book X.

† Ibid. Book V.

" the fountain, melodiously utters its whispering strains with
" inexpressible sweetness: thou too playest exquisitely on the
" pipe:"——

'Αδύ τι τὸ ψιθύρισμα καὶ ἁ πίτυς, αἰπόλε, τήνα,
"Α ποτὶ ταῖς παγαῖσι μελίσδεται· ἁδὺ δὲ καὶ τὺ
Συρίσδες· ——

With respect to the whispering or gentle rustling produced by the pines, the Greek Scholiast remarks, " That the pines whisper " when they are gently fanned, the breeze being broken by " the closeness of the leaves *." He has likewise observed, " That the word *ψιθύρισμα* is contrived on purpose, from the " peculiarity of its sound, to imitate the sound which it ex- " presses †." I may add, that the Doric words *μελίσδεται* and *συρίσδες*, instead of *μελίζεται* and *συρίζεις*, by bringing *σῖγμα* before *δέλτα*, considerably augment, in this instance, the sweetness of the sound.

* Ψιθυρίζουσι αἱ πίτυς, ὅταν ῥιπισθῶσι, τῇ στενότητι τῶν φύλλων σχιζομένης τῆς πνοῆς.

† 'Ονοματοποίηται δὲ ἡ λέξις παρὰ τὴν τοῦ ἤχου ἰδιότητα, κατὰ μίμησιν τῆς φωνῆς. Homer abounds in instances of 'Ονοματοποΐια, as is well known.

V. ACCOUNT *of the* GERMAN THEATRE. *By* HENRY MACKENZIE, Esq; F. R. S. EDIN.

[*Read by the Author, April* 21. 1788.]

NO country perhaps affords a more intereſting literary ſpeculation at preſent than *Germany*. For reſearches in ſcience and philoſophy, for laborious inveſtigations into the principles of public polity and law, ſhe had long been conſpicuous; but, till very lately, ſhe made ſcarce any pretenſion to fame in the other departments of literature, which uſually precede thoſe more abſtract and laborious purſuits I have juſt mentioned. Even in hiſtory, her writers were few; but of poetry and *belles lettres*, ſcarce a trace was to be found; and of the very little of either, which the authors of that country produced, the language in which they conveyed it, was a foreign one. But of late, Germany begins to exert herſelf in the more elegant walks of literature, with an uncommon degree of ardor; and in her literary aſpect, ſhe preſents herſelf to our obſervation in a ſingular point of view, that of a country arrived at maturity, along with the neighbouring nations, in the arts and ſciences, in the pleaſures and refinements of manners and ſociety, and yet only in its infancy with regard to writings of taſte and imagination. Theſe, however, from this very circumſtance, ſhe purſues with an enthuſiaſm, which no other ſituation could perhaps have produced; the enthuſiaſm which novelty inſpires, and which the ſeverity incident to a more cultivated and critical ſtate of literature does not reſtrain. Since the time of HALLER (who, by an extraordinary combination of talents, united the

deepeſt

deepest abstraction of science with the ease and pleasantry of the lightest poetry) and of GELLERT, the LA FONTAINE of Germany, that country has thrown into the circle of literature a greater variety of productions in poetry and belles lettres than any other nation of Europe. While other countries have been applying themselves chiefly to moral, physical and geographical enquiries, Germany, remounting as it were to the sources of ancient inspiration, has given to the world works of that creative sort, which are seldom produced in those later times, when fancy and imagination give place to the sober certainties of science and philosophy. Among those works of imagination, it is sufficient to mention several epic poems, one of which at least, the *Messiah* of *Klopstock*, is of the most acknowledged and universal reputation.

THE language of Germany, however, has not yet attained, as those who know it inform us, that perfection and regularity necessary to stamp the highest value on the productions composed in it. Its currency, for the same reason, is far from extensive; and therefore the original German works are scarce read at all beyond the circle of the empire. French and English translators, particularly the former, have made up to strangers the loss which this would otherwise have occasioned; and few books of any merit now appear in Germany, that are not republished in the French language by the booksellers of Paris.

OF these, one of the most remarkable, and, from its nature, one of the most interesting, is the *Theatre Allemande*, or a Collection of the most approved theatrical performances of Germany, translated into French by Messrs FRIEDEL and DE BONNEVILLE, which is rivalled by another collection of the same kind, though not hitherto so extensive, by Messrs JUNKER and LIEBAULT; both translations, as far as one may judge from intrinsic evidence, are executed with fidelity and ability.

As the drama of every country marks more ſtrongly than any other of its productions, the features, both of its genius and of its manners, I thought I ſhould afford a not unacceptable piece of information to this Society, by giving an account of thoſe publications, accompanied, as it naturally muſt be, with ſome remarks on dramatic compoſition in general, ariſing from the particular obſervations excited by the works in queſtion. Neither that account, nor thoſe remarks, will pretend to completeneſs or regularity. Written amidſt a variety of other occupations, with but little leiſure either of time or of mind, I only mean them as preſenting to the Members of this Society a ſketch of ſomething that merits the further enquiry of the induſtrious, and which, as an amuſement, will well repay the time which the unemployed may be induced to beſtow on it.

It appears by a preliminary diſcourſe, prefixed to Mr Friedel's tranſlation, ſomewhat contradicted, but without much effect, by the preface of Mr Junker, that it is only at a very late period that the theatre of Germany has arrived at any degree of perfection. In the year 1727, Gottsched, profeſſor of Philoſophy in the Univerſity of Leipſic, undertook a reformation of the German ſtage, till that time ſunk in a ſtate of barbariſm. But he gave only tranſlations of French plays, with one or two miſerable originals of his own, long ſince forgotten. It was not till between the years 1740 and 1750, that any performance of merit appeared, or that actors of eminence (with very few exceptions) ſeem to have exiſted to perform them. About that period, the celebrated Eckhof, the Roscius of Germany, began his theatrical career, in which he continued to delight his countrymen till his death, which happened in 1778, a year remarkable in the annals of the ſtage, ſince it deprived the world of three of its greateſt actors, Le Kain, Garrick and Eckhof.

Besides the low ſtate of polite literature in Germany before that period, of which I have taken notice above, the ſmall extent

tent of each individual ſtate muſt neceſſarily have obſtructed the progreſs of theatrical exhibition. The eſtabliſhment of a good theatre is too expenſive for the limited revenues of the ſmaller potentates, among whom great part of Germany is divided. At *Vienna*, *Berlin* and *Dreſden*, there were theatres ſupported at very conſiderable expence; but theſe, I believe, were deſtined for the opera. This would indeed naturally be the caſe, where the entertainment was meant for the Court. Dramas that rouſe the paſſions, that ſhake the ſoul, afford pleaſure only to the body of the people; the great and the faſhionable reliſh much more thoſe ſpecies of entertainment which gratify the finer ſenſes, or amuſe the lighter fancy of the indolent and the voluptuous. Muſic and dancing, or muſical dramas which include both, are always their favourite amuſements.

The progreſs of the German ſtage muſt have alſo been conſiderably impeded by the circumſtance of the language being ſo different in different parts of the empire; and in ſome of them ſo degraded in the *patois* of the country, as of courſe to make French the common language of the better ſort of people.

In the year 1747, Lessing, whom the Germans regard as the chief of their dramatic authors, produced his firſt comedy at Leipſic; and from this time downwards, a variety of authors of genius contributed to form and to eſtabliſh the theatrical taſte of Germany. Their attempts, however, ſeem ſtill to have been obſtructed by the particular ſituation of the country. No capital, like Paris and London, united or rewarded their efforts. The King of Pruſſia, from whom one would have looked for literary patronage, had always a prepoſſeſſion for French, and a contempt for German literature. We find him therefore beſtowing high honours on Le Kain, who acted occaſionally on a French theatre eſtabliſhed at Berlin, but never intereſting himſelf about the eſtabliſhment of a German ſtage. It is pretty remarkable, that the muſes of the empire found protection

protection and support chiefly from persons engaged in commerce, the first theatres of any eminence being built by the merchants of Leipsic and Hamburg. After the conclusion of the last war, however, the theatre appears to have received considerable encouragement at Vienna, Berlin, Manheim and Dresden.

About this period, the taste for sentimental and pathetic writing began to be wonderfully prevalent in Germany. The works of Sterne, and several other English authors of the same class, were read with the greatest avidity. I remember to have been told of a club or society, instituted at some town in Germany, whose name was taken from the *snuff-box*, which forms a striking incident in the celebrated story of the monk in the *Sentimental Journey*. The Poems of Wieland, Gesner, Weisse, *&c.* are full of the most refined sentiment and sensibility; and the celebrated *Sorrows of* Werter of *Goethe* carries those qualities to that enthusiastic height, which has so much captivated the young and the romantic of every country it has reached *. This prevalence of highly refined sentiment seems commonly the attendant of newly-introduced literature, when letters are the property of a few secluded men, and have not yet allied themselves to the employments or the feelings of society. The same thing took place at the revival of letters in Europe after the long night of the middle ages. The Platonic love of the ancient romance, and of the poetical dialogue of the *Provencals*, was the produce of the same high-wrought and metaphysical sentiment, which is the natural result of fancy and feeling, untutored by a knowledge of the world, or the intercourse of ordinary life.

We are not therefore to wonder, if, amidst what we might be apt to term refinement in point of sentiment and expression, we

* Soon after the publication of that little work, it became a badge of fashion among the young men of Germany, to wear as a uniform the dress which Werter is described as having on in one of his interviews with Charlotte.

we ſhould find in thoſe German dramas, a diſregard for the regularities and the decorum of the ſtage, which is conſidered as marking a very rude ſtate of the dramatic art. Such diſregard, in effect, ſome of thoſe dramas exhibit in a remarkable degree. The ſcene is ſullied with murder, and disfigured with madneſs, as often as that of the ancient Engliſh tragedy. And in one of the plays of this collection, in point of tenderneſs and paſſion, a performance of very high merit, AGNES BERNAU, the heroine of the piece, is executed on the ſtage in a manner as repugnant to the delicacy or dignity of theatrical ſituation as can well be imagined, to wit, by being drowned; and one of the executioners is exhibited puſhing her down into the water when ſhe attempts to ſave herſelf.

THIS diſregard of rule, and this licence of the ſcene, are attended with many unfavourable, and yet perhaps with ſome fortunate effects. The rules of ſound and liberal criticiſm certainly produce, in the hands of great ability and genius, the moſt exquiſite and delightful performances. Yet there is a certain reach of genius, which they may reſtrain from exertions that might ſometimes accompliſh very valuable productions. There are moments of peculiar warmth of imagination and felicity of language, which, in the courſe of a work where fancy is indulged beyond the bounds of rigid critical rule, a writer may experience above the level of his ordinary powers. Without an attention to the critical regulations of the drama, VOLTAIRE would not have written ſuch admirable tragedies; but, from the reſtraints which the neceſſity of that attention impoſes on the theatre of France, that theatre is loaded with thoſe thouſand inſipid plays which every year at Paris are exhibited and forgotten. The monotony of the modern French drama may fairly enough be imputed to that nicety and faſtidiouſneſs of a French audience, which will not ſuffer any irregularity, though ſanctioned by nature, or dignified by genius. I mean not by this to plead for any indulgence to a licence their ſtage has

lately

lately assumed in point of moral *bienseance*, which is equally unfavourable to excellence of composition and to decency of manners. The same remark might be extended to our stage, were it not now sunk to such a state of degradation as hardly to be worthy of notice.

The collection of the German theatre by JUNKER, contains, besides *Sara Sampson*, which is common to both publications, three tragedies, six comedies, a *drame* and a pastoral. That of FRIEDEL consists of twelve volumes, containing twenty-seven dramatic pieces, of which thirteen are tragedies, nine are called comedies, and five *drames*, a species of performance for which we have not yet got in English a very definite term. It holds a sort of middle place between tragedy and comedy, borrowing from the first its passions and sentiments, from the last the rank of its persons, and the fortunate nature of its conclusion.

THIS sort of drama was for some time extremely popular in France, and was thence adopted into the theatres of England and Germany, but particularly into the latter, where it seems to have been peculiarly adapted to that turn for high-wrought sensibility, which I have before mentioned as having become a sort of national taste in that country. Indeed, most of the comedies of these volumes might be classed under this denomination.

THERE are three historical plays, one of which, of the highest popularity in Germany, is *Goetz de Berliching*, founded on the history, or rather indeed detailing the history, of a chief of that name, in the war of the peasants in the time of the emperor MAXIMILIAN. This play goes beyond the utmost licence of our SHAKESPEARE, in its change of scene and multiplicity of incident. Yet this was written as late as the year 1773.

THE principal authors of these collections are LESSING, GOETHE and BRANDES. The two first are sufficiently known; the last, BRANDES, is the director of a company of German comedians;

medians; and if we may judge from his performances in this collection, one of the ableſt of the German dramatiſts, though he ſeems not to have attained in his own country ſo much conſideration as I ſhould be diſpoſed to allow him.

IN JUNKER's collection is a comedy of GELLERT's, which gives a very favourable idea of his talents for comic character and dialogue, called *The Lottery Ticket*.

WEISSE, a name of high dramatic reputation in his own country, is the author of two tragedies in theſe volumes, one of which, *Romeo and Juliet*, is an extremely popular performance in Germany. It is an imitation of SHAKESPEARE's *Romeo and Juliet*, with the plot much compreſſed and connected; but, in the ſwell of its language, and the extravagance of its alluſions, it goes rather beyond the original. *Juliet*, however, is a better and more intereſting female character than is generally found in this collection.

THERE is one performance, which, as it is of a ſingular kind, I may diſmiſs with a particular notice here, by a writer whom Germany places by the ſide of HOMER and MILTON, KLOPSTOCK, the author of the *Meſſiah*. This is the *Death of Adam*, written in a dramatic form, though, as the author himſelf informs us, not meant for repreſentation. The ſubject indeed ſeems to exclude it from the ſtage; but the ſituations, though not of a pleaſing, are of a highly intereſting kind, and the conceptions and language are marked with that force and ſublimity which his countrymen ſo enthuſiaſtically admire in KLOPSTOCK. The angel of death is introduced as a perſon in the drama, announcing to ADAM his approaching fate. The appearance of this majeſtic and terrible being is prepared in a manner uncommonly awful and ſublime. ADAM and his ſon SETH are on the ſcene. " The terrors of the ALMIGHTY (ſays " the father of mankind) are upon me. My eyes loſe you, " my ſon. What darkly gleaming light rolls before me? " Feel'ſt thou the ſhaking of this rock? Doſt thou hear the

"trembling of that hill? Upon that hill behold him! Seest "thou, my son, the angel of terror?" "'Tis night around "me, (replies SETH) but I hear the noise of sounding steps!" The sublimity of this terror, which is conveyed to the ear while invisible to sight, has been felt in the same manner, and is expressed in nearly the same words, by a poet of our own country, who, in that passage at least, has touched the lyre with the true energy of a bard. "Hark, (exclaims the Druid in Caractacus)

"Hark! heard you not yon footstep dread
"That shook the earth with thundring tread,
"——'Twas Death!"—

It will be no disparagement to either of the modern poets, if they shall be thought to have borrowed the idea from the *Oedipus Coloneus* of SOPHOCLES.

THE angel is visible to ADAM, and announces his approaching dissolution with the simplicity and solemnity of his function. The signs he gives are the sun descending behind the grove of cedars, and the return of the angel, whose steps shall again shake the earth; "Thine eye shall be dim, and thou shalt not "see me—but thou shalt hear the rock burst with the noise of "thunder—thou shalt hear, and die!" The reader is thus prepared for the awful event, and the imagination watches, from scene to scene, the sinking of the sun and the shaking of the earth, with that anxious expectation, those *minute*-terrors (if the expression may be allowed me), which, of all circumstances, give the strongest emotion to the mind. I take this short notice of the detail of the particular drama in question, though not quite in its proper place here, because it stands without the pale of theatrical criticism, and because it is the production of a writer who is but little known in this country, though his genius is revered, even to idolatry, in his own.

I NOW return to give ſome general account of the dramatic collections before us. Moſt of the pieces of which they conſiſt are plays of ſituation rather than of character. In the comedies, it is not the *miſer*, the *miſanthrope*, the *hypocrite*, that is repreſented, but a father offended by the *miſalliance* of his child, a huſband hurt by the ridiculous extravagance of his wife. The tragedies, in like manner, do not exhibit a perſonification of ambition, revenge or jealouſy, but a ſon outraged by his father, a baron offended by his prince, a prince tyranniſed over by his love. I am inclined to think the characteriſtic drama the moſt pleaſing, and generally the moſt excellent. The character of the leading perſon introduced, marks the events and the ſituations in which it is placed, in ſuch a way as ſtrongly to impreſs the imagination and the memory of the reader, and colours, as it were, that particular province of mind which the author means to delineate, with a preciſion and a force which is not found in ſcenes where the ſituation only acts on the general feelings of our nature. This kind of drama, however, is not ſo commonly found in later periods of ſociety, both becauſe thoſe later periods do not ſo frequently produce peculiar and ſtrongly diſtinguiſhed characters, as becauſe ſuch characters have been already ſeized by the earlieſt dramatic writers, who only leave to their ſucceſſors the power of tracing them through their ſubdiviſions and modes, of painting the nicer ſhades by which the ſame great features of the human mind are diſcriminated in different perſons. I think it may be remarked as a defect in the collections before us, that the dramas do not always place thoſe features in a ſtrong and ſteady light. The characters are not always perfectly or uniformly ſupported, and the perſons are ſometimes exhibited acting from motives not quite conſiſtent with the general plan of their character, nor appearing of ſufficient force to produce their actions. This may perhaps be imputed to that extreme refinement of feeling, which I have before remarked to be particularly predominant

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in theſe pieces. Objects ſeen through the medium (a medium too rather fluctuating and uncertain) in which the perſons of the drama are placed, ſtrike them with a force which the reader does not always readily allow, and become motives to a conduct of which he does not always perceive the neceſſity or the uſe. Characters ſuch as thoſe of SHAKESPEARE, which act from the original native feelings of the ſoul, are immediately acknowledged by the correſponding feelings of the audience. It is of no conſequence in this particular, that they are ſometimes ideal beings, placed in a world of fancy, different from the real. They have ſtill a ſet of feelings, conſonant to that ſphere in which they are placed, and to thoſe characters with which the poet has inveſted them. But in the metaphyſical refinements of ſentiment, the ſame thing does not take place. There the feelings are created, not the characters; and we have no leading radical idea to which we can refer them, to which we can diſcover that intimate relation, which it is the great excellence of the poet to preſerve, and the great pleaſure of the reader or the ſpectator to trace.

THE plots of theſe dramas are generally ſimple, but rather diffuſe; a fault to which the freedom from critical reſtraints of time and place, claimed by the authors of ſeveral of them, is apt to lead. They are frequently too eaſily anticipated in their concluſion; and, in the conduct, they do not produce many of thoſe ſtriking theatrical ſituations, which, even to the moſt enlightened ſpectators, are highly pleaſing, but which ſeem abſolutely eſſential to the entertainment of an ordinary audience. In peruſing ſome of theſe plays which have obtained the moſt univerſal reputation in Germany, one is led to give the audiences of that country credit for a high degree of refinement, when we are told of the unbounded applauſe they beſtow on thoſe pieces, the merit of which does by no means lie in ſtriking incidents, or in what are called *coups de theatre*, but conſiſts chiefly in a minute developement of feeling and ſenſibility,

bility; a refinement and eloquence of ſentiment which one would imagine the bulk of the people could neither underſtand nor admire. Perhaps, however, an audience may admire what it does not perfectly underſtand, if a few ſentimentaliſts of high name do but ſhew it what it ought to admire. In ſentiment, as in religion, there is a myſtical ſort of enthuſiaſm, which warms the fancy without ſubmitting itſelf to the underſtanding; in ſentiment, as in religion, enthuſiaſm is eaſily communicated. High refinements, which go far beyond real life, catch with a rapidity of infection. They are the creed of a ſect, which is always propagated with more ardor and bigotry than the rational belief of a community.

In the conduct of the fable, ſome of their authors, as I mentioned before, do not confine themſelves to any obſervance of the unities of time and place, but aſſume a licence of tranſporting their audience, even in the midſt of what they call (though by what rule I know not) an *act*, into different provinces and diſtant periods. In the reading, this offends but little; and even in repreſentation, it offends leſs than ſome of the diſciples of Aristotle are apt to ſuppoſe.

It is difficult to aſſign the limits or the power of theatrical deception. Perhaps Dr Johnson, in his excellent piece of criticiſm on the *Unities*, has allowed too little force to that to which the ſchools had before aſcribed too much. A play repreſented is certainly ſomething different from a play read; and in that repreſentation, we are hurt with any circumſtance which lets down our feelings from their ideal place, as we are, on the other hand, pleaſed with every circumſtance which rivets and confirms them there. The dreſs, the decorations, the ſcenery, and all thoſe little externals, which, in the cant language of the theatre, are called *property*, hurt us, if they do not correſpond with the ſituation and circumſtances of the perſons whom we ſee before us on the ſcene. And this cannot be from our ſenſe of the propriety of a theatrical exhibition, conſidered as ſuch,

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according to the rules of art; for the little circumſtances I mention are ſooner perceived by an ignorant and untutored ſpectator than by a critical and experienced one. A critical and experienced one is indeed a very challengeable judge of the effects of this deception. He has got too much behind the ſcene to allow it its due impreſſion on his mind; and is exerciſing other faculties than that feeling and imagination, which the leſs informed ſpectator allows to overpower him with all the pity, the wonder and the terror, with which the poet has filled his piece. In point of deception, however, ſuppoſing what I contend for to be granted, the circumſtance of *time* is, as JOHNSON very well obſerves, extremely pliant to the imagination. Nor is *place* perhaps leſs accommodating. Indeed I am inclined to think it rather more ſo, for this reaſon, that time holds a relation to ourſelves; but the mimic world of the ſtage, from which we draw our ideas of place, is ſomething quite diſtinct from the world of the pit or boxes in which we ourſelves are placed. Still, however, a violent infringement of probability in either of thoſe particulars, offends that belief which the captive fancy wiſhed to pay to the dramatic creation before it. The diviſion of acts, which is very arbitrary on our ſtage, and not leſs ſo in ſome of theſe German productions, affords, in my opinion, an opportunity favourable to this diſtance of place and lapſe of time, which, in both theatres, are ſo often indulged. When the curtain is down, and the muſic plays, there is a pauſe in our attention, a calling off of our imagination from its immediate purſuit, which ſufficiently prepares both for a very conſiderable change of place and of time, without wounding the unity of our feeling by the diſcordance of the ſcene. In the diviſion of our plays, and in that of the German ones I am now conſidering, the author is not bold enough to multiply the acts, in words, beyond the number five; but, in truth, if by an act is underſtood a ſubdiviſion of the piece, conſiſting of a certain ſeparate complete part, both the

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Englifh and German plays are frequently fplit into a much greater number. And I thought it a very juft, as well as natural anfwer, which a countryman in the pit gave to a friend of mine, who entered in the middle of one of SHAKESPEARE's tragedies, and afked him to what act they had got, "I be-"lieve, Sir, faid he, they are juft going to begin the ninth."

THE morals of thefe German plays are in general unexceptionable. There is no approach towards indelicacy, except in one or two inftances in the more ferious fcenes, to a kind of indelicacy, arifing from a want of that nice fenfe of dignity and decorum which the family of the mufe requires. There is, however, a licence of thinking on fome fubjects, that tinctures pretty ftrongly of feveral of the performances in queftion; and by a combination not unfrequent among fentimentalifts, the language is highly virtuous, while the action is libertine and immoral. From the author of the Sorrows of WERTER, this does not furprife; but in a play, written by a perfon of a grave character, Profeffor UNZER of *Altona*, one would hardly expect to have found a prayer to the virgin concluded by a folemn refolution of fuicide, and the ftrength of mind with which the heroine looks on the poifoned beverage before her, afcribed, in the very language of devotion, to the *power and efficacy of prayer*.

BESIDES the delicacy of decorum, and propriety in the manners and the language of a play, there is a fort of delicacy in its very paffions and diftrefs, which highly polifhed theatres require, the neglect of which is difagreeable to the feelings and the tafte of a very refined people. The forrow that melts, not the anguifh that tears; the fear that agitates, not the terror that overwhelms the foul, are the paffions which fuch an audience relifhes in a tragedy. The German theatre does not allow for this delicacy of feeling. Its horrors and its diftrefs affault the imagination and the heart of the reader with unfparing force; it loves to trace thofe horrors and that diftrefs

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through every ſcene and every ſituation in which they can be found; and in its diſplay of human paſſions and human ſorrows, is little ſolicitous to mitigate the atrocity of the one, or the poignancy of the other. This ſtrong painting will ſometimes diſguſt the delicacy of him who has been uſed to the finer tints of the modern ſchool; but it gives room for that ſublimity and boldneſs of picture, which is often ill exchanged for the flat inſipid repreſentation of reſtrained paſſions and chaſtened manners.

Baron RIESBECK, himſelf a German, who is therefore no bad authority on this ſubject, accounts for the prevalence of high-wrought paſſion on the German ſtage, from the particular mode of living in Germany. "The different claſſes of people, "ſays he, do not mingle ſo much in the German towns as they "do in France. To every thing which belongs to nobility, or "which has the name of nobility, or is in any way attached to "the Court, the German in middle life can have no acceſs. "His knowledge of life, and taſte for ſocial pleaſures, is much "more confined than that of our people, (the Baron writes in "the character of a Frenchman), nor does he, like the inhabi-"tants of a moderately large French town, enter into the in-"numerable incidents and accidents of common life. This "want of intereſt in uſual virtues and vices, this inſenſibility "to the little events of ordinary life, oblige the German to "look for ſtrong emotions and caricatures to entertain him on "the ſtage; whereas the Frenchman is contented with a piece "of much finer wrought plot, and willingly ſees the people he "lives and is acquainted with repreſented on the ſtage."

To this account of the Baron's may, I think, be added ſomething peculiar in the national character, which, like that of the Engliſh, is of an ardent, thinking, ſerious caſt. To men of this diſpoſition, the lighter and more ordinary views of life and manners are not intereſting. They call for deeper and more impreſſive ſcenes, ſcenes of high paſſion and ſtrong emotion.

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The Germans have accordingly adopted, with the greateſt eagerneſs, the Engliſh tragedies moſt calculated to pleaſe this turn of mind. SHAKESPEARE is their favourite author, and the model of ſome of their moſt popular tragedies. To this idea, the love of ſentiment I have before taken notice of, may be eaſily reconciled. The ſentiment theſe plays exhibit, is not the ſentiment one meets with in French authors; it is not the nice and delicate feeling of the *petites morales*, or manners; it is that deep impaſſioned ſenſibility, which reſides in ſerious and ardent minds, which can brood with melancholy, or kindle with enthuſiaſm.

IN the German comedy, ſomewhat of the ſame thoughtfulneſs, phlegm perhaps a Frenchman might call it, may be traced. We find not the gay and ſportive language with which the comic muſe of France forms her lively and elegant dialogue; not thoſe nice and delicate tints with which her light and flying pencil marks the pictures of her ſcene; but a ſtyle more ſerious and reflective in the one, and colours more ſtrong and hard in the other.

A CIRCUMSTANCE very obſervable in the German theatre, is the frequent minuteneſs and prolixity of the ſcene. This is naturally the caſe in an early and unrefined period of the drama. To ſelect ſtriking and luminous parts of a ſtory, or of a ſeries of actions, to exhibit thoſe in one ſtrong point of view, and to leave the ſubordinate parts to be filled up by the imagination of the reader or the ſpectator, is a ſort of abſtraction which belongs to a more advanced and cultivated period. In the firſt rude eſſays of painting, one picture contains different actions of the ſame perſons; and, in early narrative, every circumſtance that paſſed, and every word that was uttered by the perſons of whom the relation ſpeaks, is introduced. In dramatic poetry, in the ſame way, the earlier and leſs cultivated poets are not contented with ſhewing the perſons of the drama only in the great and important ſcenes to which the

courſe of their ſtory leads; they exhibit every concomitant ſcene in which thoſe perſons may be ſuppoſed to have been concerned. The more inventive imagination an author poſſeſſes, the more he is liable to this fault, if that imagination is not chaſtened by learning, and regulated by taſte. RICHARDSON, who may perhaps be ranked next to SHAKESPEARE among our authors of untutored genius, is an inſtance of this in later times. His painting is always in nature; but his canvas is often filled with unneceſſary figures, which add to the ſize, while they diminiſh the effect of the picture. SHAKESPEARE (as might more readily be expected) is in this particular extremely faulty; and his German admirers have not corrected this fault in their imitations of him. They are more defective than he in what may be called the unity of dialogue, *i. e.* in making their perſonages ſpeak only what is natural and important to their ſituations, and to the conduct of the piece; an error to which ſeveral of their ſcenes owe a degree of languor, as well as length, which is apt to fatigue the reader, and muſt have required very good ſpeaking indeed, not to have tired the audience.

THE ſtyle of theſe volumes is in general bold, forcible and rich; in ſome places perhaps rather too florid and ornamented. This is apt to ſtrike us more in proſe, in which moſt of the pieces in theſe collections are written, and into which they are all tranſlated, than it does in verſe; becauſe elevation of language is more expected in the latter than in the former. It has been generally held as a maxim in dramatic dialogue, that the pathetic ſhould be expreſſed in the ſimpleſt language; that deſcription and moral ſentiment may admit of the pomp of verſe and the ornaments of eloquence, but that paſſion and diſtreſs do not allow of ſuch decorations, becauſe they bring the mind into a ſituation which ſwelling or figurative language does not ſuit. This is evidently juſt to a certain degree. The mind, occupied with, and full of its own feelings, has no leiſure to

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ſtudy the expreſſions in which thoſe feelings are vented; yet I think it will be found in nature, that a certain elevated diction will often be that in which the mind will pour its moſt genuine and deepeſt ſorrows. There is a pride and dignity in ſorrow which renders it eloquent; which, riſing above the level of ordinary things, ſpeaks in a ſtyle more lofty than that of common life. I believe it will alſo be found, that, in compoſition, the aſſumed loftineſs of language will have ſome effect in producing a loftineſs of idea; that "the words that glow" will ſometimes, as it were, create "the thoughts that burn." I think it is PLATO who, ſomewhere in his works, makes a remark of this kind as to poetry, whoſe meaſure and majeſtic march give an inſpiration to the poet, which the train of thought in common language would not have produced. And I am perſuaded that the dramatic writer who, in the fervour of compoſition, gives to the diſtreſſes of his fancy a language of that elevated kind, will ſometimes, in the very flow and current of his words, feel his heart ſwell, and tears guſh from his eyes, with an energy of paſſion which a more ordinary diction would have failed to rouſe. It muſt, however, at the ſame time, be confeſſed, that the moſt common fault lies on the oppoſite ſide; and that authors of but moderate genius often inveſt their characters, rather in the parade of words than in the dignity of ſentiment, rather in a coldly imitative phraſe of feeling than in feeling itſelf. A fault of this kind is ſometimes diſcernible in the dramas before us, where, in the developement of ſentimental diſtreſs, the characters talk rather than feel their ſituation; where the poet, refining on his art, rather colours than draws the picture of the ſcene, or, to purſue the alluſion, gives us ſhades of language inſtead of ſhades of thought.

THIS laboured diſplay of ſentiment and ſenſibility is liable to the general objection which ſtrikes one in every dramatic performance, as lying againſt the perſons of the drama in-

forming us of what paſſes in their minds, not by what the ſcene ſhews in their actions, or what the ſituation naturally leads them to ſay, but, if we may be allowed to reſort to the plain honeſt confeſſion of Mr BAYES, in order to give an opportunity of introducing *good things*. To this fault, the ſimple and the poliſhed ſtate of the drama are equally liable; the firſt from that chace of images and analogies which the luxuriance of fancy dictates, and which taſte has not yet taught her to reſtrain; the other, from a rigid obſervance of order and unity, which adds to the narrative in proportion as it limits the exhibition of the ſcene. We find accordingly this defect in many paſſages of the older poets; and not leſs, and indeed in a much more continued ſtrain, in the modern dramatiſts, particularly the French, where the *tirade*, or ſtring of fine lines, is often introduced, not to expreſs the feelings of the ſpeakers, but merely to ſhew the eloquence of the poet.

IN my enumeration of the pieces contained in this collection, I mentioned, that moſt of thoſe which are called comedies, rather come under the denomination of *drames*, containing a delineation of the affections and paſſions of ordinary life, more allied to tragedy than to comedy, being only related to comedy in its perſons, but to tragedy in its ſentiments and its ſufferings. Its ſufferings, however, are rather of feeling than of ſituation, which is one great reaſon of the intereſt it excites in that claſs of people, a very amiable one, whoſe minds from nature, reading, or habit, poſſeſs an exceſſive and high ſtrained delicacy and ſenſibility. The ſituation and diſtreſſes of the perſons repreſented in it, are but little removed from the ſituation in which that claſs of readers are placed, or thoſe diſtreſſes which they often feel. Hence perhaps no ſpecies of the drama may be ſuppoſed to have a ſtronger effect on actual life and conduct. This might lead to an intereſting moral inquiry, for which the preſent is not the proper place, and which indeed has not been unnoticed by ſeveral late moral writers. In general,

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I think we may venture to pronounce theſe dramas favourable both to moral principle and to the practice of virtue. To the former, they are allowed, even by their adverſaries, to be friendly; to the latter, it may perhaps be contended that they do not always contribute, or at beſt that they only produce that momentary impreſſion, which paſſes over the mind like a golden dream, amuſing to the fancy, but without any effect on our actual conduct or diſpoſitions. The French dramas of this ſpecies, and ſome of the German ones in this collection, which ſeem to have been formed on theſe models, have a good deal of that pompous wordy declamation of virtue and ſenſibility, which, like every ſpecies of bombaſtic writing, is extremely popular at its firſt introduction, and generally maintains a number of partizans, even when aſſailed by the weapons of criticiſm or good ſenſe. Such a common-place ſort of weakneſs hurts equally the good effects of the drama, as a leſſon of morals, and the entertainment to be derived from it as a work of taſte. To the enemies of virtue, the ridicule is open; to her friends, the exhibition is painful; it is like the dotage of a perſon we love, which, though we cannot laugh at, we are conſtrained to bluſh for. Beſides, in moral effect, it loſes the advantage which, as I obſerved above, this ſpecies of drama poſſeſſes, of approaching nearer than any other to ourſelves. When we ſee ſo little truth or life in the picture, when the ſentiments ſoar ſo airy a height, we feel them as thoſe of another world, which, if we ſhould even admire, we will never concern ourſelves to imitate.

It muſt, however, be confeſſed, that though ſuch weak paſſages will naturally produce thoſe effects among people of better informed judgments and more ripened taſte; yet, by the leſs refined part of an ordinary audience, they are often received with that genuine feeling and applauſe, which, as they are produced by virtue, are friendly to her intereſts. At the repreſentation of ſome of thoſe ſcenes, where very lauda-

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ble, but very common-place maxims, were pompoufly brought forth, and received with loud plaudits, I confefs, though I thought meanly enough of the genius of the poet, I have thought, and been happy while I thought, highly of the people. The people, whofe opinions may often be folly, whofe conduct may fometimes be madnefs, but whofe fentiments are almoft always honourable and juft; the people, whom an author may delight with bombaft, may amufe with tinfel, may divert with indecency, but whom he cannot miflead in principle, nor harden into inhumanity. It is only the mob in the fide-boxes, who, in the coldnefs of felf-intereft, or the languor of out-worn diffipation, can hear unmoved the fentiments of compaffion, of generofity, or of virtue.

In examining thefe pieces in detail, and appropriating them to their refpective authors, one is immediately ftruck with the name of Lessing, whom Germany fo much reveres as one of the founders of her drama. He is the author of the firft piece in Friedel's collection, *Emilie de Galotti*, another tragedy in one act called *Philotas*, a third called *Sara Samfon*, and a drame entitled *Nathan le Sage*. He is author alfo of feveral other plays contained in the Theatre Allemand of Junker, one of which, *Minna de Barnhelm*, is reckoned the *chef d'œuvre* of German comedy. I have perufed it with all the attention to which its high character entitled it, and indeed with a great degree of the pleafure, though not with all the admiration which that high character led me to expect. It is of the graver or fentimental kind of comedy, where the characters maintain a war of generofity, from which the embarraffments and implications of the plot, not very intricate nor artificial ones, refult. The principal perfon is a Major Telheim, a difbanded officer, whofe merits his country had ill rewarded; a man of the moft confummate bravery, generofity and virtue, for whom thofe qualities have gained the love of every foldier and domeftic around him. They have procured him a ftill more valuable

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attachment, the love of the heroine of the piece, MINNA of Barnhelm, who, on hearing of the Major's regiment being difbanded, comes to Berlin to feek him, and to make him happy. The rival noblenefs of mind of thefe two characters produces the principal incidents of the piece, which, however, are not always natural, nor very happily imagined; and befides, as FIELDING jocularly fays, when comparing a fhallow book to a fhallow man, may be eafily feen through. But, with all thefe defects, and that want of comic force which the turn and fituation of the principal characters naturally occafions, the play muft pleafe and intereft every reader. There is fomething in the conftitution of the human mind fo congenial to difintereftednefs, generofity and magnanimity, that it never fails to be pleafed with fuch characters, after all the deductions which critical difcernment can make from them. Amidft the want of comic humour which I have obferved in this play, I muft not omit, however, doing juftice to a ferjeant-major of TELHEIM's regiment, and to JUSTIN his valet, who are drawn with a ftrong and natural pencil. The ftory of the fpaniel, told by the latter, when his mafter's poverty makes him wifh to difmifs him from his fervice, is one of the beft imagined, and beft told, I remember to have met with. There is a good deal of comic character and lively dialogue in fome of LESSING's lefs celebrated pieces in the collection of JUNKER; but the plots are in general extravagant and farcical.

IN judging of LESSING as a tragic writer, one will do him no injuftice by making the tragedy of *Emilie de Galotti* the criterion of that judgment. The others in thefe volumes are very inferior to this, which is certainly, in point of compofition, character and paffion, a performance of no ordinary kind. LESSING was well acquainted with the ancient drama, and wifhed to bring the theatre of his country to a point of regularity nearer to that of the ancients. He publifhed, for fome time, a periodical criticifm on theatrical compofition, called,

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"Le Dramaturgie de Hambourg." His plays, accordingly, though not exactly conformable to the Aristotelian standard, approach pretty near to it in the observation of the unities. He is said to have got into a dispute with GOETHE on this subject, in which, from a degree of timidity in his nature, he rather yielded to his antagonist. I am not sure if he has profited by confining himself more than some other of his countrymen within the bounds of the regular drama. The fable of *Emilie de Galotti*, as well as of his other tragedies, is more regular than happy, and the denouement neither natural nor pleasing. It is founded on circumstances somewhat similar to those in the story of *Virginia*. A Prince of Guastalla is desperately enamoured of EMILIE DE GALOTTI, who is just about to be married to a man of rank and fortune, the Count APPIANI. On the day of his marriage, he is way-laid by order of a wicked minister of the prince, and murdered. His bride is brought to the Prince's country-seat, where, to prevent any chance of her dishonour, her father kills her.

AFTER the first reading of *Emilie*, I was disposed to wonder at the reputation it had acquired; but a second placed it higher in my estimation. This was naturally the case in a performance where the whole was neither so perfect nor so interesting as some of the scenes in detail were forcible and striking. The heroine EMILIE DE GALOTTI is but imperfectly drawn, and not very well supported. Indeed, it may in general be observed in these pieces, that the characters of the female personages are by much the most defective, both in beauty and in force. This may perhaps be ascribed to the state of society in Germany, where the sex is less an object of consideration and respect than in France, and some other parts of the Continent. But there is another lady in this tragedy, the *Countess d'Orsina*, the betrayed and abandoned mistress of the Prince, whose character the poet has delineated with great ability; and one scene, in which she is introduced along with the father of EMILIE,

Emilie, in genuine expreſſion of paſſion, and pointed force of dialogue, may be compared to ſome of the beſt which the modern ſtage can boaſt.

In the developement of the ſecret foldings of the heart, Lessing ſeems deeply ſkilled, and the opening ſcenes of this tragedy contain ſome of thoſe little incidents that mark an intimacy with human nature, which genius alone can claim. But in its progreſs we find, in ſome degree, a want of that ſtrong and juſt delineation and ſupport of character, but chiefly of that probable conduct and intereſting ſituation, which are the great and peculiar requiſites of dramatic excellence. It ſeems alſo defective in the pathetic, for which certainly the ſubject afforded very great room, and which, in a ſimilar ſituation, our countryman Rowe has contrived ſo ſtrongly to excite.

Of Lessing's performances in theſe volumes, the next in merit, though, in my opinion, at a conſiderable diſtance, is *Sara Samſon*, an Engliſh ſtory, of which the idea ſeems chiefly taken from *Clariſſa*, though one character in it, that of a violent and profligate woman, is evidently borrowed from *Millwood* in *George Barnwell*. I muſt venture to doubt, whether a character of this ſort be proper for filling a principal place in tragedy. There is a degree of infamy in the vice of ſuch a perſon that is ſcarcely ſuitable to the dignity of the higher drama, and which diſguſts us with its appearance. The *Marwood* of Lessing is introduced in ſuch a manner as to heighten that diſguſt. The amiable female of the piece, *Sara Samſon*, is no exception from the general defect of female character in this collection. And her father, who is placed in the tender ſituation of which ſeveral authors have made ſo affecting a uſe, the parent of a child ſeduced from honour, though ſtill alive to virtue, is inſipidly drawn, and awkwardly introduced. In this tragedy, is an incident, of which Lessing ſeems to be fond, as he has repeated it with very little variation in another tragedy called *L'Eſprit Fort*, a dream, related by the heroine, pre-

 dictive

dictive of the cataſtrophe. This, as it anticipates the concluſion, is always faulty. No part of the conduct of a play is more nice and difficult than that degree of information which the author is to give the audience in the courſe of it. In general, he ſhould certainly not foreſtal their expectations, by opening his plot too ſoon. But there is an admirable theatrical effect which often reſults from letting the audience know what the perſons of the drama are ignorant of, which ſtretches, if I may uſe the expreſſion, the cords of fear, anxiety and hope in the ſpectators to the higheſt pitch, through ſcenes which otherwiſe would produce theſe feelings in an inferior, as well as in a momentary degree. This knowledge in the audience, of *Merope's* ſon, while ſhe, in ignorance of his perſon, is on the point of putting him to death, is one of the moſt intereſting ſituations which dramatic invention has ever produced; and there is nothing on the French ſtage which equals the horror of that ſcene of CREBILLON's *Atree et Thyeſte,* where the devoted brother attempts to diſguiſe himſelf from *Atreus,* while the terrified ſpectators know him all the while, and tremble at every look and word which they think will diſcover him.

NEXT to LESSING, in point of name, is GOETHE, the author of two tragedies in this collection, *Goetz de Berliching* and *Clavidgo,* and of a drame entitled *Stella.* The firſt I have already mentioned as highly irregular in its plan, being a life thrown into dialogue rather than a tragedy. The *coſtume* of the age in which the events are ſuppoſed to have happened, is very well preſerved. The ſimple manners, the fidelity, the valour and the generoſity of a German knight, are pourtrayed in a variety of natural ſcenes. This national quality, I preſume, has been the cauſe of its high fame in Germany, to which it ſeems to me to have otherwiſe not a perfectly adequate claim. His *Clavidgo* is founded on an incident which happened to the celebrated CARON DE BEAUMARCHAIS in Spain, who is introduced as a perſon of the drama, under the name of *Ronac,* an

an anagram of *Caron*, with the letters a little tranſpoſed. The diſtreſs of the play ariſes from the falſehood of a lover, who leaves his miſtreſs after being engaged to marry her. Neither the delineation of the characters, nor the management of the plot in the firſt two acts, is entitled to much applauſe; but the laſt act, which paſſes in ſight of the corpſe of *Maria*, is wrought up with uncommon force, and muſt, on the ſtage, be productive of high effect. His third performance, *Stella*, is ſtrongly marked with that enthuſiaſtic ſentiment and refined ſenſibility, which, in the *Sorrows of Werter*, he has ſo warmly indulged; and in point of immoral effect, the drama is equally reprehenſible with the novel. Its concluſion is in the boldeſt ſtyle of this ſentimental refinement; ſince it gives to the hero two wives, with whom he is to ſhare that heart, to which the incidents of the play have ſhewn the claims of both.

After Lessing and Goethe, Brandes ſeems to be the author in theſe volumes next entitled to notice, and indeed, in my opinion, the leaſt exceptionable of them all. His two comedies, *Le Comte d'Olbach*, and *L'Hotel Garni*, are highly intereſting in their fable, ſpirited and natural in their dialogue, and contain ſituations and incidents truly theatrical, and extremely affecting.

Among the comedies of theſe volumes, is a very pleaſant one, entitled *Le Creancier*, by Mr Richter. A paragraph in his preface is worthy of notice, as it ſtrongly marks the prevailing tendency of the German taſte in theatrical performances. "In theſe days, ſays he, when all the world reads
" Shakespeare and Goethe, a drama like mine, which con-
" tains no outrageous paſſions, of which the ſtyle is neither
" metaphorical nor bombaſtic, which ventures to follow the
" good old Ariſtotelian rules, ſo long exploded among us,
" can hardly hope to pleaſe the *Ariſtarchuſes* of our modern
" ſchool.

"It is true, I might obſerve to theſe gentlemen, that an "honeſt banker, who has not loſt his wits, will, in all probabi-"lity, neither ſpeak nor act like *King Lear*, nor his clerk like "*Jago*, nor his daughter's maid like the confidante of Queen "*Cleopatra*. But theſe old faſhioned obſervations would pro-"bably not ſave my poor comedy from condemnation."

There is one little piece in the collection of Friedel, which every reader muſt applaud, even if his applauſe had not been anticipated by the judgment of the late King of Pruſſia, who pronounces it the only very good German comedy. This is the *Attelage de Poſte*, by Colonel Emdorff, an officer in the Imperial ſervice. The plot is founded on the violent love for horſes of a German Count, who barters his miſtreſs with his rival for a ſet of carriage-horſes. The characters are truly comic, the incidents highly amuſing, the dialogue infinitely eaſy, lively and natural, and ſo perfectly appropriated to the ſpeakers, that one might aſcertain the perſons, though their names were not affixed to the ſpeeches.

But the moſt remarkable, and the moſt ſtrongly impreſſive of all the pieces contained in theſe volumes, is that by which the collection of Mr Friedel is cloſed, *Les Voleurs*, a tragedy by Mr Schiller, a young man, who, at the time of writing it, was only twenty-three. Bred in the *Ecole Militaire* of *Wirtemberg*, he had little opportunity of informing his mind by letters, or of knowing mankind by obſervation. But amidſt the cloiſtered ignorance incident to his ſituation, his genius, by its own native warmth and vigour, produced this wonderful drama, which ſhews indeed, as might be expected, a certain want of acquaintance with the manners, as well as a total diſregard of dramatic regularity, but in which the author, fortunate, if we dare ſay ſo, in theſe defects, has drawn from the ſources of an ardent and creative imagination, characters and ſituations of the moſt intereſting and impreſſive kind, and has endowed thoſe characters with a language in the higheſt degree

gree eloquent, impaſſioned and ſublime. With a particular detail of this tragedy, I ſhall cloſe the account (I am afraid a very imperfect, though without the apology of being a ſhort one) which I have taken the liberty to lay before this Society, of the *Theatre Allemand*.

A YOUNG man, of high birth and expectations, *Charles*, eldeſt ſon of the *Comte de Moor*, endowed by nature with a ſoul of fire and a heart full of ſenſibility, is led away, in the prime of youth, by the love of pleaſure and diſſipation too common at that age. After running a courſe of thoughtleſs and criminal extravagance, he liſtens to the voice of virtue, which had been ſtifled, not loſt, in his heart, and writes to his father, whom amidſt all his vice and folly he had never ceaſed to love, a letter full of penitence and contrition, deſiring to return to his duty, and to be received again to pardon and to favour. This is intercepted by the villany of a younger brother, who manages ſo as to perſuade his father that his ſon *Charles* (who appears to have been his great favourite) is totally abandoned to villany and vice; in conſequence of which, the old man throws him utterly from his regard, and ſends him a letter renouncing him for ever, and containing that paternal malediction, ſo dreadful to the ſenſibility of a ſon who loved his parent. On receipt of this, *Charles* becomes deſperate; and, amidſt the ſtorm of his feelings, outraged by what he thinks the inhumanity of his father, readily accepts of a propoſal made by ſome of his diſſipated companions, to leave a world in which they had nothing but contempt and poverty to expect, to fly to the foreſts of Bohemia, and there to eſtabliſh themſelves into a ſociety of robbers and banditti, of which he was to be the chief. In the horrid duties of this new employment, he ſhews all that wonderful magnanimity, that perſuaſive eloquence, that undaunted valour, which would have graced a better ſtation; yet amidſt the elevation and activity of mind with which the exerciſe and the ſucceſs of theſe qualities

are

are accompanied, his heart is preſſed down by remorſe, and melted by the tender recollection of that virtuous happineſs which, in the days of youth and innocence, he had once enjoyed. The curſe of a father whom he had revered and loved, the deſertion of a miſtreſs, a couſin of his own, of whom he was deſperately enamoured, the ſenſe of his outcaſt and abandoned ſituation, and of thoſe violations of virtue and morality to which it neceſſarily leads; thoſe rending feelings, thoſe melting remembrances, joined to that high ſenſe of perverted honour which links him to his band, and that ardent valour which makes their enterpriſes of glory; theſe form a character of the moſt energetic and intereſting kind, and the author has given to his hero a loftineſs and power of expreſſion fully adequate to the terrors and the paſſions which his ſituation and his feelings produce. The intrinſic force of this dramatic character is heightened by the ſingular circumſtances in which it is placed. Captain of a band of inexorable and ſanguinary banditti, whoſe furious valour he wields to the moſt deſperate purpoſes; living with thoſe aſſociates, amidſt woods and deſarts, terrible and ſavage as the wolves they have diſplaced; this preſents to the fancy a kind of preternatural perſonage, wrapped in all the gloomy grandeur of viſionary beings.

But to return to the narrative of the tragedy.

His younger brother *Francis* having ſucceeded in removing this favourite of his father, now looks to the death of the old man as the complete accompliſhment of his wiſhes to attain the fortune and honours of his family. To effect this helliſh purpoſe, he makes uſe of his father's ſtill remaining tenderneſs for that very ſon whom the traitor's arts had driven from his love. He employs one *Herman*, a tool of his villany, to perſonate a ſoldier, who had been the companion of *Charles*, and to relate a fabricated ſtory of the ſufferings and death of that unfortunate young man, who, according to him, had been reduced, by the ſeverity of his father, to the moſt extreme and pitiable indi-

gence,

gence, from which he had at laſt been relieved by death, having fallen fighting gallantly in an action with the infidels, and in his laſt words had breathed out the name of his father and of his *Amelia*. The old Count feels this relation as his inhuman ſon expected; he faints at its cloſe, and is carried off lifeleſs from the ſtage. The traitor *Francis* reaps the fruit of his villany; he reaps, but his conſcience does not permit him to enjoy it; and he is ever after preſented as the martyr of remorſe, haunted by the terrors of inward guilt. His aſſociate *Herman* appears to yield to contrition; he braves the anger of his lord, and reſolves to embrace the firſt opportunity of counteracting his villany.

THOUGH the great and the terrible be the moſt prominent features of this drama, there are ſcenes in which the pathetic and the tender prevail in a very uncommon degree; and the impreſſion they make on the reader is heightened by the contraſt of that bold unbending ſpirit which he ſees melted by their force. One of theſe, the ſecond ſcene of the third act, is ſo ſtriking, that I cannot forbear laying it before the Society in Engliſh. They will make allowance for what it muſt loſe in this form, when they conſider that it is the tranſlation of a tranſlation.

THE band are encamped on a height on the banks of the Danube, after a hard-fought battle with a party of Bohemian horſe, which had been ſent to take them; but which, by the unparalleled valour and exertions of *Moor* and his friends, they had defeated. He enters, overcome with fatigue and thirſt.

" I MUST reſt here, (*throwing himſelf on the ground*); my " limbs are broken with fatigue, and my parched tongue " cleaves to my mouth. I would have aſked ſome of you to " fetch me a little water from that river, but you too are weary " almoſt to death. (*One of the band goes out, unperceived by Moor,* " *to fetch him ſome water.*)

" *Grim*,

" *Grim*, (*another of his band*) 'Tis a long time ſince our flaſks " were empty of wine. How majeſtically the ſun ſets there " below!

" *Moor*, (*looking ſtedfaſtly on the ſetting ſun*) 'Tis thus that a " hero dies, and the nations admire his fall!

" *G.* It ſeems to move you.

" *M.* In my youth, it was my favourite idea to live like " him, (*looking earneſtly on the ſun*) to die like him! 'Twas the " fancy of a young man.

" *G.* 'Twas even ſo.

" *M.* There was a time—(*drawing his hat over his eyes*)— " leave me alone, my friends.

" *G.* Moor, Moor! do you ail aught? Your colour " changes.

" *M.* There was a time when I could not ſleep if I had " forgot my prayers before I laid me down.

" *G.* 'Tis folly all—Would you, like a boy, be ſchooled by " the remembrance of your infant days?

" *M.* My infant days! Oh! (*leaning his head on the boſom of* " *Grim.*)

" *G.* Think of theſe no more. Be not a child again, I pray " you.

" *M.* A child again! Would that I were!

" *G.* Rouse yourſelf for ſhame! See how the landſcape " ſmiles—how beautiful the evening looks!

" *M.* Aye, my friends, this earth is ſo beautiful—

" *G.* Why, that is well.

" *M.* This ſcene ſo grand—

" *G.* You ſpeak it truly. I love to hear you talk thus.

" *M.* And what am I, in this world that is ſo beautiful! " A thing ſo vile on this magnificent work of heaven!—The " prodigal ſon!

" *G.* Moor! Moor!

" *M.*

" *M.* My innocence—give me back my innocence. Look " how every thing in nature is cheered by the ſmile of ſpring. " Why in this air, ſo pure to them, ſhould I breathe the " blaſting ſmoke of hell? When all around us are happy— " when gentle peace has united them—the world one bleſſed " family, and its Father there above—who is not my Father! " I alone ſhut out—the prodigal ſon—excluded from the por- " tion of his children—(*ſhrinking back with horror*) ſurrounded " with crimes—with murder—bound to them with chains of " iron.

" *G.* (*to the reſt of the band*) I never ſaw him thus before.

" *M.* (*with a voice of tenderneſs*) Ah! if it were poſſible for " me to be born again—to be born a beggar, the meaneſt " thing that were not a guilty one! With the labour of theſe " hands I would purchaſe the wearineſs of peace. Oh! that " with the ſweat of my brow, though that ſweat were blood, " I could buy one guiltleſs hour—the luxury of one tear!

" *G.* Patience, friends; his fit is almoſt over.

" *M.* There was a time when my tears flowed freely. Oh " peaceful days!—that ſaw me in my father's houſe, in my " native fields!—Ye ſmiling fields!—ye valleys made for en- " thuſiaſm to wander in! Scenes of my happy infancy—will " ye never return? Will ye never breathe on this burning bo- " ſom your gales of peace and joy?—Nature, why art thou " dark around me?—They will never, never return; never on " this boſom will they breathe—they are gone—gone for " ever!"

Subdued by the tenderneſs of the recollection which this ſcene expreſſes, *Charles* viſits his native caſtle in diſguiſe; he finds his father dead, his brother *Francis* in poſſeſſion of his inheritance, and his miſtreſs ready to take the veil. After yielding for a while to thoſe ſofter feelings which the ſcenes of his infancy recal, he recollects the outcaſt abandonment of his

 own

own ſituation, makes himſelf known, at the inſtant of parting, to his *Amelia*, and flies to rejoin his deſperate aſſociates.

In this ſituation of things, the fourth act commences. The ſcene is of that ſavage kind, which prepares the imagination for the horrors to enſue. 'Tis night; and the remains of the band are aſſembled on a deſert heath, near to the ruins of an ancient tower, round which the winds whiſtle, and the owl ſhrieks. They had watched three days and nights of danger and alarm, and all, except their unhappy chief, whom remorſe and anguiſh keep awake, yield to their fatigue, and lay themſelves on the ground to ſleep. *Moor* remains alone, and walks to and fro, like the ſovereign ſpirit of the night, revolving in his troubled, but daring ſoul, this world and the next. In this world, he has now nothing left to hope, and he looks, with deſperate calmneſs, on the dark and unknown gulph of that to come. His ſoliloquy is of that ſublime and broken ſort which expreſſes the agitation of a great but erring mind, yielding to remorſe for crimes which have ſtained his life, but not corrupted his ſoul, and left him, amidſt the outrages of violence and vice, the ſentiments and the ſufferings of virtue and of feeling. After a pauſe of gloomy meditation, he breaks out in the following words, (to my tranſlation of which the Society will afford the indulgence I formerly ſolicited.)

——" A long long night!—on which no morning will " ever dawn! Think ye that *Moor* will tremble? Shades of " the victims of this aſſaſſinating ſword! I ſee your bleeding " wounds, I look on your livid lips, and hear the laſt agoni" zing groans they breathe—but I tremble not.—Theſe are but " links of that eternal chain, which he who ſits in yonder " heaven holds in his hand. He ſtamped theſe horrors on my " deſtiny. Even amidſt the innocent, the happy days of my " unſullied infancy, his eye ſaw them, and ſealed them on my " fate! (*he draws a piſtol*) The barrier betwixt eternity and " time, this little inſtrument can burſt—and then—Thou

" dread

" dread unknown! whither wilt thou lead? where wilt thou " place me? If thou leav'ſt me this conſcious ſelf, 'tis that " muſt create my heaven or my hell. Amidſt the waſte of a " world which thine anger has deſtroyed, I can people the ſi-" lent void with thought. Or wilt thou, in new and untried " ſtates, lead me through various miſery to nothing? Thou " mayeſt annihilate my being; but while this ſoul is left, will " not its freedom and its force remain? 'Tis equal where— " *(putting up his piſtol)* I will not now ſhrink from the ſuffer-" ings of the preſent—the deſtiny of *Moor* ſhall be fulfilled."

He is ſilent—he hears the tread of approaching feet, and preſently a figure glides before him, and knocks at the grated wicket of the tower. The figure ſpeaks, " Riſe, man of ſor-" row, inhabitant of the tower, thy repaſt is here." A feeble voice anſwers from the dungeon within, " *Herman*, is it thou? " Bring'ſt thou, like the prophet's raven, his food to a linger-" ing wretch, that lives by the crumbs which thy pity affords " him?" *Moor*, who had ſhrunk back in amazement, now advances, and deſires the man to ſtop. That man is *Herman*. He draws his ſword; but is almoſt inſtantly diſarmed. " What " art thou, ſays the aſtoniſhed *Herman*, whoſe touch withers " like that of death? Art thou the demon of this horrid " place? the ſpirit of this murderous tower?" " I am, ſays " *Moor*; the exterminating angel is my name; and yet I have " fleſh and bones like thee. But what wretch is in that " tower? I will burſt his chains." He draws from his pocket the paſs-keys which his profeſſion employs; he opens the tower; the ſkeleton figure of a famiſhed wretch creeps from the dungeon—" Horrible phantom!" ſays the aſtoniſhed *Moor*, in a low and ſtifled voice, " my father!"

It is his father, whom the inhuman *Francis* (taking advantage of the long faint into which the account of his ſon's death had thrown him) had buried alive in the dungeon of the tower. When *Charles* is informed of this, and his other

 treacheries,

treacheries, by *Herman*, the penitent aſſociate of his villany, he wakes his band, and, in the rage of filial revenge, diſpatches one of the boldeſt of the troop to force the caſtle of his brother, and bring him alive before them. The old man is ſtill ignorant of his deliverer's being his ſon, and waits, terrified and weak, the diſcloſing of this myſtery of juſtice and of vengeance.

THE laſt act opens with a ſcene in the caſtle of the guilty *Francis*, who is now in poſſeſſion of the county of *Moor*. He is exhibited in all the diſmay and diſtraction of awakened remorſe. After ſome incoherent dialogue (wrought up with the liveliеſt circumſtances of guilty terror) with a ſervant, who had watched his ſleep, and followed him, when he had ſtarted from his bed, into the ſaloon of the caſtle, they are told by a frightened domeſtic, that a troop of horſemen are approaching at a gallop, with terrifying ſhouts. The Count is petrified by his guilty fears, and cannot give orders for defence. His followers, however, for a while diſpute the paſſage of the band, till the caſtle is ſet on fire. Its maſter is ſtill more loſt in the horrors of his ſituation; and, after an unavailing requeſt to his ſervant, to ſave him from the vengeance of his enemies, by putting him to death, is left alone amidſt the approaching flames, wiſhing to die, yet dreading death, till he hears the thunder of the band at the gate, which ſhakes, burſts, and the entering foe ſeizes him alive, and carries him off, according to the command of his captain.

THE ſcene changes to the heath, where *Moor* and his old father are diſcovered amidſt the war of contending feelings with which the ſon is torn. He often reſolves to diſcloſe himſelf to his father; but the conſciouſneſs of his fallen and abandoned ſtate withholds him. The poet has contrived, by placing the father and ſon in this particular ſituation, to infuſe into this ſcene a degree of tenderneſs which melts the heart, mixed with a horror which chills the imagination. When the old man complains

complains that he has now no ſon to cloſe his eyes, his ſon throws himſelf on the neck of his father, yet is unable to diſcover that this wretch, this robber, this aſſaſſin, is his *Charles*. At that moment, a diſtant noiſe is heard, and preſently the dim gleam of torches begins to illumine the ſcene around them. The glare of their light increaſes; the voices are heard more near; the accuſtomed muſic of their ſavage triumph ſounds; and the faithful band of *Moor*, true to their commiſſion of vengeance, bring the criminal *Francis* chained before his father and his brother. It is impoſſible to convey by narrative the horrid ſublimity of the ſituation which this ſcene preſents, or of thoſe expreſſions to which the wounded ſenſibility of *Moor*, wrought up to the moſt inſatiable revenge againſt the author of his father's miſery and his own, gives birth. The reader could hardly conceive any modern imagination, how pregnant ſoever with tragic terrors, to produce a ſcene that could vie with the dread picture of the fourth act; when he has read the fifth, he will find the horror equalled, and the intereſt ſurpaſſed.

Moor leads the wretched *Francis* before his father. The old man is willing to forgive him; but his brother has devoted him to vengeance. He deſires the band to lead his father to a remote part of the wood; and then, ſettling the fury of his revenge into the terrible ſolemnity of diſpaſſionate juſtice, he places his brother in the midſt of his fierce aſſociates, and deſires them to pronounce ſentence on his crimes. They conſult ſome time together on an adequate puniſhment; and then, felicitating themſelves on the thought, they throw him into the dungeon in which this barbarous parricide had buried his father. The old man is brought in. He feels the yearnings of paternal affection for his guilty ſon, and exclaims againſt the cruelty of his avengers. *Moor* throws himſelf into his arms, and diſcovers to him his favourite, his *Charles*. Juſt then, *Amelia*, who had eſcaped from the caſtle of his brother, enters, and

and runs to embrace her lover and his father. The father feels all the pleaſure of his ſon and his niece reſtored, and fondly anticipates the felicity they are to enjoy. But *Moor* bids them check the expectation of happineſs, and look only for deſperation and horror. " Your paternal curſe, ſays he, conſigned " me to perdition. Theſe men you ſee are robbers—mur-" derers—your ſon is their chief." The exhauſted ſtrength of the old man cannot ſtand the ſhock; he expires in the arms of his ſon. His miſtreſs ſtill ſurvives; and though dumb with terror and grief, folds him in her arms, and ſhews the moſt ardent affection for her *Charles*. Warm in his love, as in every other feeling, *Moor* had doated on her to diſtraction; he forgets himſelf in her embraces, and for a moment thinks he will live and be happy with his *Amelia*. " Come from her arms, " cries one of the boldeſt of his troop, or I will ſpeak what " ſhall freeze your blood." " Think, exclaims another, (while " they level their pieces at his head) of your vow to be ours " for ever. Ours you are, and heaven nor hell can win you " from us." Their voices rouſe the remembrance of his ſituation. But his ſoul is too proud to yield to threats. " You " are murderers, ſays he, and I am your chief. Down with " theſe arms, and know your maſter." Awed by the ſounds they are accuſtomed to obey, the banditti lower their arms.— " To be great, *Moor* muſt be free. I would not give this tri-" umph for all the elyſium of love. (*He draws his ſword.*) " Call not that madneſs of which your ſouls want ſtrength to " ſee the grandeur. The greatneſs of deſpair is above the ken " of wiſdom. On actions ſuch as this, reflection muſt follow, " not wiſdom pauſe."

He plunges his ſword into the boſom of *Amelia*. Struck with the barbarous heroiſm of the deed, his aſſociates fall at his feet, acknowledge his unparalleled fidelity, and vow to be his ſlaves for ever. " No, ſays he, with a determined and pe-" trifying calmneſs; the deſtiny of *Moor* is accompliſhed.

" Thus

" Thus far it was in human power to go, and thus far he has " gone; but here his courſe is cloſed, and his genius cries out, " *All is conſummated.*" He diſmiſſes his band, except two favourite officers, with an exhortation to uſe their invincible courage in the ſervice of their country. To theſe two favourites, whoſe ſouls are not ſo deeply tinctured in blood, he bequeaths his paternal domain, and deſires them to leave him, and to devote their future lives to virtue and obedience to the laws. " And " I too, he concludes, will obey the laws; I will bear the " ſterneſt puniſhment of their decree." And he goes to deliver himſelf up to juſtice.

I HAVE ventured this long and particular account of the tragedy in queſtion, becauſe it appears to me one of the moſt uncommon productions of untutored genius that modern times can boaſt. Confeſſedly irregular and faulty, both in plan and conduct, it were needleſs, and perhaps unfair, to offer any remarks on its defects. But its power over the heart and the imagination muſt be acknowledged. Every body has heard the anecdote of its effects on the ſcholars at the ſchool of *Fribourg*, where it was repreſented ſoon after its firſt appearance. They were ſo ſtruck and captivated with the grandeur of the character of its hero *Moor*, that they agreed to form a band like his in the foreſts of Bohemia, had elected a young nobleman for their chief, and had pitched on a beautiful young lady for his *Amelia*, whom they were to carry off from her parents houſe, to accompany their flight. To the accompliſhment of this deſign, they had bound themſelves by the moſt ſolemn and tremendous oaths; but the conſpiracy was diſcovered by an accident, and its execution prevented.

THE energy of this tragedy's effect is not to be wondered at, eſpecially on young minds, whoſe imaginations are readily inflamed by the enthuſiaſm of gigantic enterpriſe and deſperate valour, whoſe ſenſibility is eaſily excited by the ſufferings of a

great

great unhappy mind, and who feel a ſort of dignity and pride in leaving the beaten road of worldly prudence, though the path by which they leave it may ſometimes deviate from moral rectitude. But hence, to ſome parts of an audience, the danger of a drama ſuch as this. It covers the natural deformity of criminal actions with the veil of high ſentiment and virtuous feeling, and thus ſeparates (if I may be pardoned the expreſſion) the *moral ſenſe* from that morality which it ought to produce. This the author has, ſince its firſt publication, been candid enough to acknowledge, and reprobates, in terms perhaps more ſtrong than it deſerves, his own production as of a very pernicious tendency. He has left his native country, *Wirtemberg*, from which I believe indeed ſome conſequences of the publication of this tragedy had driven him, and now lives at *Manheim*, where he publiſhes a periodical work, and has written one or two other tragedies, which have a high reputation. If his genius can accommodate itſelf to better ſubjects, and to a more regular conduct of the drama, no modern poet ſeems to poſſeſs powers ſo capable of bending the mind before him, of rouſing its feelings by the elevation of his ſentiments, or of thrilling them with the terrors of his imagination.

VI.

VI. THEORY *of the* MOODS *of* VERBS. *By JAMES GREGORY*, M. D. F. R. S. EDIN. *Fellow of the Royal College of Physicians, and Professor of the Theory of Physic in the University of* EDINBURGH.

[*Read by the Author, June* 18. *and July* 16. 1787.]

IN the prosecution of certain philological and philosophical speculations, very ample specimens of which have already been submitted to the consideration of the Royal Society of Edinburgh, I had occasion to consider more minutely than I believe had ever been done before, many particulars relating to the nature, the structure, and the import of Verbs.

THOSE speculations related chiefly or solely to the general radical import of every verb and every class of verbs, without any regard to the peculiar meaning or nature of the various inflections or parts of a Verb; such as, moods, tenses, persons and numbers. It was impossible, however, for me altogether to avoid attending to these modifications of the general meaning of every Verb; especially to the nature and import of the Moods of verbs, which appears to me a very curious and interesting point in the theory of language.

As I had not the good fortune to meet with any account of the Moods of verbs, which appeared to me complete or just, in the writings of those grammarians and philologists that I have had an opportunity of consulting, I was tempted to undertake the investigation of the nature of them myself. The result of

that undertaking I now have the honour to ſubmit to the conſideration of the Royal Society.

As there is ſomething peculiar in the plan and manner of it, it is proper to mention the reaſon of this peculiarity. In thoſe accounts of the moods of verbs which I have ſeen, there ſeemed to be a want of ſufficiently numerous and extenſive and accurate obſervations of the particular facts that were to be explained or accounted for; a want of ſufficiently preciſe and diſtinct notions of the general import of the moods; a haſty and careleſs admiſſion of certain general principles not duly aſcertained, and a vague uſe of certain general and comprehenſive terms, which were not ſufficiently explained or underſtood.

In order to avoid theſe errors, and to ſupply theſe defects, I have proceeded on a plan more nearly akin to that which has long been ſucceſsfully employed in phyſical inveſtigations; beginning with a collection of obſervations relating to the moods of verbs; from theſe deducing certain general principles, and verifying theſe principles by further obſervation, and even experiment. Such a plan is undoubtedly laborious, and may appear tedious; but I think it has advantages amply ſufficient to compenſate theſe inconveniences.

I must mention likewiſe, that this Eſſay bears a particular and very intimate relation to the doctrine concerning the moods of verbs, laid down by the learned author of the treatiſe on the *Origin and Progreſs of Language*, (Vol. II.) with which I may preſume my hearers to be ſufficiently acquainted.

The account which he gives of the number, the nature, and the import of the moods of verbs, though very acute, and in many reſpects perfectly juſt, is certainly very incomplete, and in one important circumſtance it is very obſcure; which makes me ſuſpect, that, on this point, he had not carried his inveſtigation ſo far as to obtain a complete and diſtinct view of the ſubject which he was treating.

But

But though I make many remarks on his doctrine, and often refer to it, my Essay is by no means intended to cavil at it, but, on the contrary, to make use of it, as being, on the whole, the best disquisition on the subject that I have seen; to correct what is erroneous, and to supply what is wanting, in his treatise, and to carry the investigation farther than he had done.

I agree perfectly with this learned author in thinking that the *infinitive* is most improperly called a *mood:* and I think the observation a very important one; for, on this account, it is to the *infinitive, exclusively*, that we should turn our thoughts, when we endeavour to investigate the general import of the Verb, with a view to ascertain the *accident* which it denotes, and be led, step by step, to form a distinct notion of what is common in the *accidents* of all verbs, and of what is peculiar in the *accidents* of the several classes of them, and thereby be enabled to give good definitions, specifying the essence of a Verb, and the characteristic import of the different classes of verbs, such as substantive, neuter, active intransitive, active transitive, passive, and reflected verbs. The infinitive, I own, does not express the pure general meaning of the verb; for it comprehends likewise the circumstances of time, and in some languages those of person, and of course of number, and perhaps of gender. *Scribere. Scripsisse. Scripturum esse. Scripturas esse.*

But the infinitive (so far as I can perceive) denotes no *energy* or modification of thought (such as, affirming, commanding, asking or wishing) that is peculiar to itself, as the other moods do; but only that kind of thought, or combination of thoughts, which is common to all the others. Now, some peculiarity of that kind I take to be the very essence of a mood.

YET the thought expressed by the infinitive is clearly apprehended, and plainly shews that the word denoting it is a verb.

Non est VIVERE *sed* VALERE *vita.*

Sæpe etiam steriles INCENDERE *profuit agros,*
Atque levem stipulam crepitantibus URERE *flammis.*

——*Pudet hæc opprobria nobis*
Et DICI POTUISSE, *et non* POTUISSE REFELLI.

READING (says BACON) makes a full man, *speaking* a ready man, and *writing* an exact man.

(THESE English words in *ing*, will be called participles, or perhaps verbal nouns; they have the form of *participles* and verbal nouns, but the meaning of infinitives; and may be translated into Greek and Latin by infinitives. But it is of no consequence whether they be called *participles* or *infinitives;* the meaning of them is obvious, and is the same with that of the Latin *infinitives.)*

THE meaning or thoughts expressed by these infinitives, are as plainly characteristic of verbs as those denoted by *Vivo sed non valeo. Incendite steriles agros—urite levem stipulam. Opprobria dicuntur nobis.* Yet in the latter there is *mood*, while in the former there is not. Whence it follows that *mood*, properly so called, is not essential to a verb. It is only the capacity or susceptibility of *mood*, that can with propriety be said to be essential to a verb. This distinction, which I think of some importance, may be sufficiently explained and illustrated by the following examples. It is not division, but divisibility, that is essential to a geometrical line; it is not fluidity, but fusibility, that is essential to lead; not motion, but mobility, nor rest, but the capacity of being at rest, that is essential to body. But *rest* is essential to space, and, for aught I know, *motion* may be so to light.

I

I SUSPECT therefore ſome inaccuracy in the learned author's manner of expreſſing himſelf, when he ſays in one page, (161) that moods are eſſential to verbs, and in the next page remarks that the infinitive is not a mood. This would imply, that a verb, when put in the infinitive, ceaſed to be a verb; which he does not expreſsly ſay, though he comes very near to it, in the following words: " As to the infinitive, I hold it to be no " mood, though it be commonly called ſo; becauſe it expreſſes " no energy of the mind of the ſpeaker, but ſimply the action" (he ſhould certainly have ſaid more generally the *accident*, as in *eſſe*, *valere*, or *cadere*) " of the verb, with the addition of time. " It is therefore uſed, either as a noun, or it ſerves to connect " the verb with another verb, or a noun, and ſo is uſeful in " ſyntax." But ſtill I would aſk, When it is uſed in theſe or other ways, and is accordingly uſeful in ſyntax, does it *bona fide* ceaſe to be a verb? I own I do not think it does; for this reaſon, that the thought expreſſed by means of the *infinitive*, may be expreſſed in ſynonymous and convertible phraſes, in different languages, by means of other parts or moods of the verb. " *To be* or *not to be*, that is the queſtion," is equivalent in meaning, though ſuperior in ſimplicity, beauty and force of expreſſion, to " The queſtion is, whether we ſhall be or ſhall " not be."

—— *Nec quicquam tibi prodeſt*
Aerias TENTASSE *domos, animoque rotundum*
PERCURRISSE *polum, morituro.*

Nec quicquam tibi prodeſt quod aerias domos TENTAVERIS, *et animo* PERCURRERIS *polum.*

MOREOVER, it muſt be taken into conſideration, that the infinitive not only appears as the *nomen verbi*, (which ſome have called it) but expreſſes fully the *accident* of the verb, whether this be mere exiſtence, or ſtate, or event, or intranſitive action, or tranſitive action, that is, action with relation of various

ous kinds; and of courſe it has the proper *regimen* of the verb, when it expreſſes *action* and *relation*, or, in grammatical language, is tranſitive; as in *percurriſſe*, *tentaſſe*, *urere*, *incendere*, in the preceding examples.

Dico, *credo*, *puto*, *Titium exiſtere*, *valere*, *jacere*, *cecidiſſe*, *procubuiſſe*, *projeciſſe Mævium*, *projectum fuiſſe a Mævio*, have the very ſame meaning with *Dico*, &c. *quod Titius exiſtat*, *quod jaceat*, *quod ceciderit*, *procubuerit*, *projecerit Mævium*, *projectus fuerit a Mævio*.

I CANNOT help thinking, that, in theſe caſes, the infinitives, as well as the ſubjunctives, are truly verbs, though ſtripped of that circumſtance which is, in ſtrict propriety of language, called *mood*. Nor do the *infinitives* as thus uſed acquire any further meaning, in addition to the radical import of the verb with tenſe, like the proper moods; but the *ſubjunctives* after *quod* loſe their peculiar meaning as *moods*, and ſignify no more than bare *infinitives*.

I THINK ſome more illuſtration may be given to this ſubject, by conſidering the import of participles, which partake of the nature both of verbs and of adjectives; and that of verbal nouns, which partake of the nature and meaning of verbs and of ſubſtantive nouns.

IT is an acknowledged fact with reſpect to participles, and it is equally true with reſpect to verbal nouns, that, by means of them, various thoughts, commonly expreſſed by the moods of verbs, or by the infinitives of them, may be expreſſed with great accuracy, and ſometimes with advantage in compoſition, by enabling us to leſſen the number of verbs in a ſentence, or to vary occaſionally the ſtructure of it. *Nec quicquam tibi prodeſt morituro tua* TENTATIO *domuum aeriarum*, *et* CURSUS *tuus circa polum*, though a very crabbed inelegant ſentence, has the very ſame meaning with HORACE's beautiful lines, and with the proſe verſion immediately ſubjoined to it.

WHY are not *tentatio* and *curſus* reckoned verbs, as well as *tentaſſe* and *percurriſſe*? They are ſurely very near akin.

THE

THE anſwer given to this queſtion by the author of the Eſſay on the *Origin and Progreſs of Language*, and which he ſays is plain, I muſt own appears to me very obſcure and unſatisfactory. Nor can I think that the defect is entirely in me, and that I ought to underſtand it; for I can ſpecify what is wanting to the anſwer which he gives, in order to make it plain and ſatisfactory. His anſwer is,

" THAT it (to wit a verbal noun, like *curſus* or *tentatio*) ex-
" preſſes no energy of the mind of the ſpeaker, who pronounces
" the words; nor does it affirm that the thing exiſts or does not
" exiſt; nor does it command that it ſhould or ſhould not exiſt;
" nor does it wiſh that it may or may not exiſt; but ſimply gives
" us the conception of the mind of the ſpeaker." *Page* 167.

BEFORE we can fully underſtand this anſwer, (which ſeems to apply to *infinitives* as well as to *verbal nouns*), or of courſe judge whether it be juſt and complete, or not, we muſt know what the author means by *energy*, and what by *conception*, what more or leſs he apprehends there is in the one than in the other, or how he diſtinguiſhes them. Nor can this be known but by finding what there is in common among all the *energies*, (for ſomething common among them, even as conceived by him, it is demonſtrable there *muſt be*) and not belonging to any ſimple *conceptions*. We have *energy* expreſſed, and of courſe a verb conſtituted, even according to his definition of a verb, without affirmation, when we wiſh or command; without command, when we affirm or wiſh; without wiſh, when we command or affirm: Yet in all theſe caſes we have equally and indiſputably a verb. How ſhall we know what is in common to them all? How much of the meaning of a verb is in a verbal noun? What is wanting, beſides the ſuſceptibility of *mood*? Whence does this ſuſceptibility of mood ariſe, or wherein does it conſiſt? Does it depend on the combination of the notion of time with that of the proper *accident* of a verb, which combination takes place in the infinitive, and even remains in the participles of a verb, but not in a verbal noun?

Exiſtentia

Exiſtentia (whether good Latin or not) is the predicament or *accident* of *being.*

Vita is the ſtate or *accident* of *living.* *Caſus, obitus,* the events or *accidents* of *falling* and of *dying.*

Cogitatio, lectio, ſcriptio, curſus, ædificatio, trucidatio, are the *accidents* or actions of thinking, reading, writing, running, building and murdering.

In Engliſh, almoſt any noun ſubſtantive may occaſionally be converted into a verb, by uſing it to denote thoſe thoughts, or combinations of thoughts, ſuch as exiſtence, ſtate, event, activity, intranſitive, or tranſitive, or reflected, and paſſiveneſs or being the object or ſubject of activity, which are conceived to conſtitute the eſſence of a verb.

Water is plainly a noun.

Watered a participle.

To water a verb, without *mood.*

He watereth, water thou, may it be watered, it was watered, a verb with *mood.*

A watering, a verbal noun, retaining the accident, but not the import of *mood;* and nearly allied to the infinitive *to water,* in every reſpect but that it does not involve the notion of time, as the infinitives *to water, to have watered, &c.* plainly do.

These are but hints. *Valeant quantum valere poſſint.*

I suspect that the author whoſe doctrine I am conſidering, has been raſh in limiting the number of *moods* to three; the *indicative,* expreſſing affirmation, (and of courſe negation) under which he comprehends the *ſubjunctive,* as being nearly of the ſame import, and denoting affirmation, only qualified or conditional; the *optative,* expreſſing wiſhing or praying; and the *imperative,* expreſſing command.

I should think the ſame kind of reaſons that he urges againſt admitting an *interrogative* mood, namely, that " it is " not expreſſed by any different form of the verb, but only " by particles, or by a certain arrangement of the words,"

and

and for rejecting the *potential* mood, and for making the *subjunctive* only a branch of the *indicative*, would apply with equal force against admitting an *optative* mood, at least in some languages, as for instance in our own.

In the following lines,

> *Te* SPECTEM *suprema mihi cum venerit hora;*
> *Te* TENEAM *moriens deficiente manu.*

The verbs *spectem* and *teneam* express very clearly the *energy* of wishing. This modification of thought is denoted in Latin by inflection, and would be so in Greek, σε θεῴμην, σε κατεχοιμι, and will be allowed to constitute a perfect mood. But in English it must be denoted by a certain arrangement of the words, and therefore should be no mood, any more than interrogation. "Thee "may I look on when my last hour shall come; thee may I "grasp, when dying, in my failing hand." *I may look on thee, I may grasp thee*, have meanings as different from those denoted by the same words differently arranged, as *Cæsar was killed*, is from *was Cæsar killed?*

If I am rightly informed, the Chinese language has no *imperative mood;* and those who speak it are obliged to employ a very clumsy circumlocution, by means of a verb signifying *command*, to express the familiar meaning of our imperative.

It does not appear clearly to me, that the *subjunctive* mood expresses merely qualified or conditional affirmation in every case, though undoubtedly it does so in many cases. In the following lines of Horace,

> *Ulla si juris tibi pejerati*
> *Pœna*, Barine, NOCUISSET *unquam;*
> *Dente si nigro* FIERES, *vel uno*
> *Turpior ungui*,
> Crederem.

 The

The word *crederem* to be ſure denotes merely a qualified or conditional affirmation: I might, could, would, or ſhould believe, if a certain event took place. But the verbs expreſſing this condition and ſuppoſition, are alſo in the *ſubjunctive*, *nocuiſſet*, *fieres*, after the particle *ſi*. With this particle, they might have been put in the *indicative*, and the ſenſe would ſtill have been complete, *nocuerat*, *fiebas*. The ſame thought may be expreſſed accurately in Engliſh, without the uſe of any particle correſponding to *ſi*, and merely by the peculiar arrangement of the words, juſt as was done with the wiſh of TIBULLUS, "Had "any puniſhment ever overtaken you for your broken vows; "were but one of your teeth growing black, or even were but "one of your nails becoming leſs beautiful, I ſhould believe "you."

I CANNOT conceive that the three firſt verbs in this ſentence denote any affirmation at all, conditional or unconditional, but a very plain ſuppoſition. And this thought ſeems to me to be as well entitled to be called an *energy*, as TIBULLUS's wiſh; and when it is expreſſed (no matter in what way, whether by inflection, by augment, or by peculiar arrangement) by a verb, it muſt be either a perfect grammatical mood, or ſomething very near akin to one.

THE very ſame kind of thought, to wit ſuppoſition, is expreſſed by *circumlocution*, and a kind of *metaphor*, in the following lines.

PONE *me, pigris ubi nulla campis*
Arbor æſtiva recreatur aura:
PONE *ſub curru nimium propinqui*
Solis, in terra domibus negata.

IN which *pone*, though in the *imperative* mood, expreſſes no command, but only ſuppoſition or condition. This *Captain Macheath* and *Polly Peachum* (or Mr GAY for them) underſtood perfectly;

perfectly; and accordingly translate the thought very well, without either an *imperative* or a *particle*, by *arrangement*.

Were I laid on Greenland's coast,
Were I sold on India's soil.

It may be remarked too, that Horace expresses his qualified or conditional affirmation, which is subjoined to the supposition by a verb in the indicative, not in the subjunctive mood.

Dulce ridentem LALAGEN AMABO.

Macheath takes the common *subjunctive*:

Too soon the half year's night WOULD *pass;*

And *Polly*, the *potential*,

I COULD *mock the sultry toil.*

—— *Omnia novit*
Græculus esuriens; in cœlum, JUSSERIS, IBIT.

A little hungry Greek knows every thing; he will go to heaven, *should you desire him*. This is *conditional affirmation*, expressed by the *indicative*, and *supposition* by the *subjunctive* mood.

Illum et parentis CREDIDERIM *sui*
Fregisse cervicem.

I *could believe* that he had murdered his father. This I conceive to be an instance of the *potential mood;* if not of the verb *credo*, at least of human thought.

 WHATEVER

WHATEVER may be thought of the preceding obſervations, it muſt at leaſt be admitted, that the moods of verbs may be conſidered in two very different points of view; either *with relation to any particular language*, or *with relation to human thought*, which muſt be ſuppoſed the ſame in all ages and nations. For the ſake of diſtinctneſs, I ſhall call the expreſſions of them, by inflection or otherwiſe in language, *grammatical moods;* and the thoughts, or combinations of thoughts, ſo expreſſed, as well as ſimilar combinations of thoughts, though not always, or perhaps never expreſſed in the ſame way, I ſhall call *energies*, or *modifications*, or *moods of thought*.

WITH reſpect to the former of theſe things in any particular language, there can be no diſpute or difficulty. Any tolerably good grammar of that language will ſhew at once the number and the forms of them in it; and the exact import of each of them, and the proper application of them all, will ſoon be learned by attending to the uſe of thoſe who ſpeak and write that language well. But the latter (the moods of thought) muſt be inveſtigated in a different and much more laborious way; by ſtrict attention to our own thoughts, and with ſuch aid as the ſtructure of language, and obſervation, and even experiment afford.

ALL languages, I believe, are very defective in reſpect of that variety and accuracy of combination and of diſtinction, which we know with infallible certainty take place in thought. Nor do I know of any particular in which language is more deficient, than in the expreſſing of thoſe *energies* or modifications of thought, ſome of which always are, and all of which might be expreſſed by the grammatical moods of verbs. Of this, there cannot be a clearer proof, than the well known facts, that we are obliged to expreſs by the ſame mood very different modifications or *energies* of thought, and that the number of moods, as marked by inflection or otherwiſe, is different in different languages, which, of courſe, do not correſpond ſo far as

as to admit of perfect and literal translation in all cases from one to another, or at least not without circumlocution.

YET, unfavourable as this circumstance must, at first sight, appear to the hopes of one who wishes to investigate the nature of the moods of verbs, and ultimately to ascertain the nature of a verb itself, I think it is chiefly by attending to it, by considering what modifications of thought are expressed by grammatical *moods* in different languages, and by comparing them with such modifications of thought as are never, or at least not usually, expressed in that way, and by examining how it comes to pass that some of them are, while others are not so expressed, that we shall be led to discover wherein they agree or differ, that is, to learn the common nature of all, and the particular nature of each of them, which is the immediate object of enquiry.

THE province of the schoolmaster who undertakes to teach any particular language, English, French, Latin, or Greek, extends no farther than to explain the meaning and shew the use of the grammatical moods which are found in that language which he teaches; and his scholars, at least at an early period of life, can go no farther.

BUT the province of the philologist, who wishes to examine the structure of language, and of the philosopher, who wishes to investigate the laws of human thought, is much more extensive. Every grammatical *mood* that is found in any one language, is to him a proof of a corresponding distinction, or variety of *energy*, or modification of thought; for all men are by nature capable of learning any language. Nor does he stop here. From considering how many *energies* are expressed by grammatical *moods*, he is led to form a more extensive and just notion of those *energies*, and may naturally suspect, and with a little attention will soon discover, that there are many other similar *energies*, which are not expressed in any language; and to these, as well as to those that are expressed, in some or

all

all languages, by grammatical moods, he ought unqueſtionably to direct his attention.

It is evident at firſt ſight, that a variety of thoughts, or modifications of thought, may be combined, or conceived and expreſſed, along with the general meaning or *accident* denoted by any verb.

It is equally evident, that only a few of theſe modifications of thought are expreſſed by grammatical moods in Greek, Latin or in the modern European languages.

It is alſo evident, that in theſe languages, one grammatical mood is often employed to denote very different modifications of, or additions to, the thought, or combination of thoughts, which is expreſſed equally by every part of the verb, and which may be found without *mood*, though not without *tenſe*, in the *infinitive*.

And it is plain alſo, that both thoſe additions and modifications of thought, which commonly are, and thoſe which are not expreſſed by the grammatical moods of any verb, may be expreſſed by the infinitive of that verb, with the addition and *regimen* (that is, *marked relation)* of another verb. And this additional or auxiliary verb muſt be in the firſt perſon, either ſingular or plural, of the preſent tenſe of the indicative mood. In ſome caſes, there may be more than one ſtep in this proceſs of reſolution, as in interrogation; but it always terminates ultimately in a verb in the preſent of the indicative, and in the *firſt perſon*, as the phraſe to be reſolved is the expreſſion of the thought of the perſon or perſons ſpeaking.

Affirming, denying, teſtifying, foretelling or prophecying, aſking, anſwering, wiſhing, hoping, expecting, believing, knowing, doubting, ſuppoſing, ſtipulating, being able, commanding, praying, requeſting, ſupplicating, loving, hating, fearing, deſpairing, being accuſtomed, wondering, admiring, warning, ſwearing, adviſing, refuſing, exhorting, diſſuading, encouraging, promiſing, threatening, and perhaps numberleſs other modifications

cations of thought, for which I cannot eaſily find names, all admit very readily of being combined with the general import of a verb, and form with it various more complicated meanings, which are eaſily diſtinguiſhable from one another, and are not convertible, and therefore muſt be different. There are various degrees and kinds of reſemblance or affinity among them, in conſequence of which they admit of being arranged, and of courſe of having different more general names given with propriety to the ſeveral diviſions or claſſes of them. And there is ſomething common among them all, to which the name of *energy*, without any impropriety (that I can ſee), may be applied. If every one of them had been expreſſed in all languages, by variations as ſtriking as thoſe of *τυπτω*, *τυπτοιμι*, and *τυπτε*, they *muſt* have been acknowledged as diſtinct *moods* of the verb. They are equally *moods* or *diſtinct energies* of thought, whether expreſſed in language or not, if they be but underſtood by thoſe who uſe language; as for inſtance, in the caſe of the grammatical mood called the *imperative*, by which we expreſs occaſionally prayer to GOD, command to a ſlave, requeſt to a ſuperior, advice to an equal or to any one, order as from an officer to his ſubaltern, ſupplication to one whom we cannot reſiſt. Theſe *ſpecific* differences of thought were perhaps in ſome meaſure expreſſed in Greek by the *tenſes* of the imperative, the exact uſes and import of which I muſt own I underſtand but very imperfectly.

IF they could all be arranged under three heads, as the author of the *Origin and Progreſs of Language* conceives, affirming, wiſhing and commanding; or if they could all be referred to one head, affirmation, as many philologiſts think they may, this would be but a ſmall addition to our knowledge concerning them, compared to what we might expect to obtain by a more accurate examination of them; and it muſt be acknowledged to be ſomewhat raſh to attempt to arrange them, without firſt examining them carefully.

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The case of the *moods* of verbs is exactly parallel to that of their *tenses*, which is very accurately pointed out and happily illustrated by the learned author of the treatise on the *Origin and Progress of Language*.

Almost every language has its own advantages and disadvantages in the expressing of the various divisions and relations of time; but the conception of these divisions and relations of time must be the same in all mankind. So it is with the conception and the expression of *moods* or *energies*, and indeed with the conception of every thing else which can be expressed by verbs, or by any other words. As in one of his own instances: "The "Lord *gave*, and the Lord *hath taken away;* blessed be the "name of the Lord." There is a precision and a beauty in this use of the simple contrasted with the compound past tense, which cannot be attained in Latin. *Dominus* DEDIT, *et Dominus* ABSTULIT; *benedictum sit nomen Domini.* But it might be attained in Greek, by using the aorist for *gave*, and the preterperfect for *hath taken away*. On looking into the Septuagint, I do not, however, find that this delicacy of expression has been attempted. But the genius of the Greek language has led the translators to another nicety and propriety of expression, which cannot be attained in any other language, nor indeed explained without a circumlocution: Ὁ Κυριος ἐδωκεν, ὁ Κυριος ἀφειλατο· ἐιη το ὀνομα Κυριου ἐυλογημενον. In this passage, ἐδωκεν is the aorist of the active voice of the verb signifying *to give;* ἀφειλατο is the aorist of the middle voice of the verb signifying *to take away.* The Greek sentence therefore expresses, The Lord gave, the Lord took away *to himself*, took back to himself, or simply *took back*. *Dominus* DEDIT, *Dominus* RECEPIT. If the Greek verb ἀφαιρεω had a preterperfect middle, and if this tense of the middle voice had, like most other parts of the middle verb, a kind of reciprocal or reflected meaning, on which points I dare not presume to decide, but must leave them to the judgment of grammarians, it would be possible to express in Greek both the

the niceties in queſtion. Yet it cannot be doubted, that all mankind are capable of underſtanding them perfectly, whether they uſe a language in which they can be expreſſed by mere inflections or not.

By means of the ſame *tenſe* and the ſame *mood,* to wit, the future of the indicative, we are accuſtomed to expreſs either mere futurity, and of courſe a prophecy, or an intention or purpoſe, or a threat, or a promiſe.

—— *Improviſa Lethi*
Vis rapuit RAPIETQUE *gentes.* Hor.

Quo nos cunque FERET *melior fortuna parente,*
IBIMUS *O ſocii comiteſque.* Hor.

Cras ingens ITERABIMUS *æquor.* Hor.

Ille Deûm vitam ACCIPIET, *Diviſque* VIDEBIT
Permiſtos Heroas, et ipſe VIDEBITUR *illis :*
Pacatumque REGET *patriis virtutibus orbem.* Virg.

Verberibus cæſum te in piſtrinum Dave DEDAM *uſque ad necem.*
Ter.

Quarum, quæ forma pulcherrima, Deiopeiam
Connubio JUNGAM *ſtabili, propriamque* DICABO. Virg.

In the two firſt of theſe inſtances from Horace, we have, I think, the bare expreſſion of what is to come to paſs.

In the third and fourth, we have not only futurity, but intention or purpoſe, plainly expreſſed.

The prophecies in the four inſtances, from Virgil's *Pollio,* are, I apprehend, ſomething more than what is expreſſed or underſtood in the two firſt of the preceding examples, and dif-

ferent from what is expreſſed in the two laſt of them. The future events mentioned ſeem to be announced with authority, or ſomething like ſupernatural knowledge or information, which I take to be eſſential to the notion of prophecy.

But *Juno*'s promiſe of a handſome wife to *Æolus*, and *Simo's* threatening of a ſevere whipping and perpetual impriſonment and hard labour to *Davus*, are by no means mere predictions of ſuch good or evil to them, nor yet bare enunciations of the intentions of the ſpeakers to them, but ſomething very different; other *energies*, modifications of thought, or moods, in ſo far at leaſt as mood is predicable of thought, which I think it is completely. For if there were two or ten different forms or inflections of a verb in any language, or in all languages, to expreſs any one *mood* of thought, for inſtance affirmation, wiſh, or command, they would not be different *moods*, but only different forms of the ſame *mood*. This is not altogether an imaginary caſe. In Engliſh we have, at leaſt in ſome parts of our verbs, two forms or grammatical moods for one mood of thought; one of them ſimple, and only marked by inflection of the primary verb; the other compound, conſiſting of an auxiliary in addition to the primary verb; and in this caſe the inflection is in the auxiliary verb alone. *I write. I do write. They wrote. They did write.* (*They did wrote* or *they do wrote*, would be ſoleciſms.) *Write thou. Do thou write.* Every perſon, I think, muſt acknowledge, that theſe are not inſtances of two indicative and of two imperative moods in Engliſh, but only two forms or expreſſions of one indicative and of one imperative mood. If ſo, then it follows that *mood* is generally conceived to be properly an attribute or predicate of thought alone, while only the expreſſion of it, by inflection or otherwiſe, belongs to grammatical verbs, juſt as the firſt and ſecond future, or the firſt and ſecond aoriſt, of the regular Greek verbs, are not two futures and two paſt tenſes, but only two different forms or expreſſions of one future and of one paſt tenſe, which

which tenſes are uniformly underſtood by all mankind. While the preſent, the imperfect, the aoriſt, the perfect, the pluſquam-perfect, and the future, are really different *tenſes*, or expreſſions of different notions of the relation of the general import of the verb to time; which expreſſions and notions are by no means convertible, and certainly may be underſtood by all mankind, though they are not found diſtinguiſhed in all languages. In ſhort, we muſt draw no inference with reſpect to the nature, the number, the affinities, or the arrangements of the moods of verbs, from the inflections or other variations employed in language, without taking into conſideration alſo the relation which thoſe inflections bear to human thought.

I HAVE further to add to theſe remarks on the import of the *moods* of verbs, that ſuch is the affinity or mutual relation among them, that they may often, by circumlocution, and the introduction of an additional verb, and ſometimes without any ſuch addition to the principal verb, and merely by a kind of metaphor, be interchanged, or ſubſtituted one for another, without materially affecting the ſenſe of the paſſages wherein they occur, and ſometimes with the manifeſt effect of giving a more full and particular expoſition of the meaning of ſuch paſ-ſages. This I mention, not for the ſake of any advantage that can in general be obtained by ſuch interchange, or ſubſtitution, but that I may point out that it is not properly a reſolution or decompoſition of the meaning of the ſeveral moods, as ſome philologiſts have ſuppoſed, and have thought an important diſ-covery in grammar, but a mere circumlocution, and a kind of paraphraſe of the ſhorter and more common expreſſion, and ſometimes a mere metaphor, inſtead of a literal expreſſion of thought. That it can be no reſolution of a more complicated into ſeveral ſimpler meanings, appears plainly from this conſi-deration, that it is *mutual* among the moods; the ſuppoſed ſimpler being as eaſily reſolvable into the ſuppoſed complicated, as theſe are into them. But of this afterwards. In general,

the expreſſion by the common, or what we may call the natural mood, is as clear and intelligible as the circumlocution, or ſuppoſed reſolution of it, and much ſhorter, and more animated and forcible, and of courſe more agreeable and proper.

It muſt be owned, however, that ſometimes there is a great and manifeſt beauty and advantage, not only in point of variety, but in force and animation of expreſſion, obtained by uſing a mood of the verb, and a form of ſpeech different from what might be termed the natural one, and what would expreſs the literal meaning of the ſpeaker. Thus, in the ode of Horace, already quoted, the uſe of the *imperative mood* inſtead of the *ſubjunctive*, which would expreſs the literal meaning, appears to me advantageous, even putting all regard to verſe out of the queſtion. Pone *me pigris*, &c. Pone *ſub curru*, &c. is ſurely more forcible and animated than *Si ponerer*, or *Si eſſem poſitus*, or ſimply *poſitus*, though the general meaning be the ſame. And Gay's lines, in imitation of theſe two ſtanzas of Horace,

> *Were I laid on Greenland's coaſt,*
> *Were I ſold on India's ſoil,*

though highly beautiful, and in one reſpect, I mean the boldneſs of the imagery introduced, ſuperior both to Horace's own lines, and to thoſe of his tranſlator, are leſs animated than either the original or the tranſlation,

> Place me *where never ſummer breeze*
> *Unbinds the earth or fans the trees;*
> Place me *beneath the burning ray,*
> *Where rolls the rapid car of day.*

All ſuch applications of the imperative mood I conſider as metaphorical; underſtanding by the term metaphor, the *trans-*

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ferring of any word or phraſe, and employing it to expreſs a thought different from what it denotes in its original, ſtrict, and literal ſignification; which I take to be the very eſſence and proper definition of this figure of ſpeech.

In like manner, the *interrogative mood*, inſtead of the *conditional* or *ſubjunctive*, which would fully and clearly have expreſſed the literal meaning of the poet, gives peculiar animation and ſpirit to the following lines:

Fervet avaritia miſeroque cupidine pectus?
Laudis amore tumes?

Are you a covetous wretch? Are you a coxcomb?—If you are a miſer, If you are a coxcomb, would ſurely be flat.

And, on the ſame principle, ſuch expreſſions as the following, *Shall we receive good at the hand of* God, *and ſhall we not alſo receive evil?—Shall I do this great evil, and ſin againſt* God? are more animated and forcible than the plain literal expreſſions of the ſame thoughts would be.

It is more remarkable, that ſometimes a kind of beauty and force, not indeed from greater animation, for ſimple command and interrogation, as expreſſed by the imperative and interrogative moods, are, I believe, the moſt animated enunciations of thought, but from greater ſolemnity, may be given by employing the *indicative mood*, where either the *imperative* or the *interrogative* would fully have expreſſed the ſpeaker's meaning.

Lydia DIC *per omneis*
Te deos ORO, *Sybarin cur* PROPERES *amando*
Perdere: cur, *&c.*

Then follow all the articles of interrogation. The general meaning would have been completely expreſſed without the *imperative* DIC, and the *indicative* ORO; yet I preſume no perſon

of

of taſte and judgment will diſpute, that, independently of the verſification, there is a beauty and force in HORACE's expreſſion far beyond what there would be in the ſimple interrogation, *Lydia cur Sybarin properas amando perdere?*

THE future of the *indicative* is employed in ſome caſes wherein the *imperative* mood would expreſs the literal meaning of the ſpeaker; as for inſtance, in the Decalogue, the expreſſions, *Thou ſhalt not kill*, *Thou ſhalt not ſteal*, *Thou ſhalt not commit adultery*, have not the proper future meaning, but are the moſt abſolute commands, or rather prohibitions, much more forcible, becauſe more ſolemn, than *Kill not*, *Steal not*, &c.

THE preceding obſervations on the nature and import of the moods of verbs, are ſo imperfect and ſo deſultory, that it may appear very raſh to draw any formal inferences from them. I hope, however, they are ſo far at leaſt intelligible and juſt, that the concluſions which I have in view, and which I think might be fairly deduced from a more ample and more methodical collection of ſimilar obſervations, will neither appear abſurd nor paradoxical.

THEY are chiefly the following.

I. THAT the *energies*, or modifications of thought, expreſſed by the moods of verbs, are ſuch as may be expreſſed ſeparately by other verbs, and *chiefly* by *active* verbs; or, in the phraſeology of the author of the eſſay on the *Origin and Progreſs of Language*, That the *energies* of the mind of the ſpeaker, denoted by the moods of verbs, are truly *accidents*, and chiefly *actions*.

THIS perhaps the learned author was not fully aware of, elſe he would not have uſed, in his definition of a verb, a phraſe which may be fairly tranſlated, " A verb is a word chiefly ſig-" nificant of being and of action, of the action of the mind " of the ſpeaker relative to that action," *&c.* Or, if he had been aware of this, he muſt, I think, have been led to examine

more

more accurately the nature of the energies, actions, or accidents denoted by the moods of verbs.

Yet, from his uniformly employing the term *energy* to denote the general import of all moods, we may presume, that he had some conception of that intimate relation between the import of the accidents of some and that of the moods of all verbs. For he must have known, that *energy*, though a compound Greek word, and *action*, though a simple Latin word, when applied to the operations of mind, are perfectly synonymous; and he very properly mentions *action* as one of the chief *accidents* denoted by verbs.

His definition might even be fairly stated thus. " A verb " is a word chiefly significant of accident, of the accident of " the mind of the speaker relative to that accident," &c. For this is only substituting the *generic* term *accident* for the *specific* term *energy* or *action;* so that the proposition, though less particular and accurate, would still be true.

II. That the *energies* expressed by the moods of verbs are *chiefly* the *social* operations of mind, as they have been very properly termed by Dr Reid; that is to say, such as imply the belief of some other intelligent being to whom they relate, and which cannot be supposed to take place in a solitary being.

III. That the grammatical moods of verbs are concise modes of expressing some of those combinations of thoughts, which occur most frequently, and are most important and striking.

IV. That the number of grammatical moods is limited by the same circumstances which seem to limit the variety, precision, and perfection of language, in other respects; and particularly by the convenience of those who use it, and who in general will have no more moods to their verbs, and no more words or inflections of any kind, than they have absolute occasion

cafion for; and, of courfe, muft often employ one mood as they do one word, or one inflection, in various fenfes, that is, to exprefs occafionally different thoughts.

V. THAT grammatical moods contribute greatly to the beauty and perfection of language, by the brevity, animation, and force, which they give to the expreffion of our moft familiar and interefting combinations of thoughts, which may indeed be expreffed, in fome meafure, by circumlocution, and the ufe of additional verbs, but not with the fame advantages.

VI. THAT grammatical moods of verbs, like other inflections of words, exprefs much better than any fucceffion of words can do, the intimate connection and relation of various thoughts, which are not fucceffive, but fimultaneous or coexiftent, and which appear unnaturally disjointed, and in fome meafure altered, when they are expreffed by a feries of words denoting each of them feparately and in fucceffion.

SOME of thefe conclufions, efpecially the third, the fifth and the fixth, are fo intimately connected, that it is difficult to confider them feparately; and as it is of no confequence to keep them quite diftinct in the following illuftrations, I fhall confider them pretty much together, as I conceive they tend to explain and illuftrate one another.

I. THE firft of thofe conclufions can hardly be thought a novelty, if it be confidered that feveral philologifts have maintained, that fome of the moods are *refolvable* into fuch circuitous expreffions, by means of other additional verbs. In truth, they are all, in fome meafure, *convertible*, though, in ftrict propriety of language, not *refolvable*, nor even *perfectly* convertible, in that way.

THE *indicative*, which denotes affirmation, is nearly the fame in meaning, and of courfe is nearly convertible, with a verb

of

of affirming in the *firſt perſon* (either ſingular or plural) of the *preſent* of the *indicative*, and the general import of the primary verb, without mood, that is, in the infinitive. *Titius ſcribit, dico, dicimus, Titium ſcribere, quod Titius ſcribat. I ſay, we ſay, that he writes.* This kind of expreſſion is a mere pleonaſm. But ſomething very nearly approaching to it is often uſed in very ſolemn language, as in that of the Holy Scripture, and with a good effect. *Verily I ſay unto thee*, &c.

The *imperative mood* is in ſome meaſure convertible with a verb of commanding, ſuch as *Jubeo*, in the firſt perſon of the preſent of the indicative, and the primary verb without mood.

I nunc, et verſus tecum meditare canoros.
Jubeo te nunc ire et tecum meditari, &c.
Jubeo, dico me jubere.

In like manner, the *optative mood* is, in ſome meaſure, reſolvable or convertible by means of the primary verb without mood, and a verb of wiſhing, ſuch as *opto* or *cupio*, in the firſt perſon of the preſent of the indicative. *Te teneam, te ſpectem. Opto, cupio te tenere, te ſpectare.* It has been found unneceſſary, but it would undoubtedly be poſſible, and on ſome occaſions might be uſeful, to have grammatical moods, either by inflection or by arrangement, (like *may I hold, may I ſee*) to denote *ſpero te tenere, deſpero te tenere, confido te tenere*, or *te ſpectaturum.*

The *interrogative mood* is not reſolvable exactly in the ſame way, by the primary verb without mood, and the *indicative* of another verb: there is another ſtep in it; and, after all, the reſolution is ſtill leſs perfect than in the other moods.

Quid faciam? Moriar? et Amyntam perdet Amyntas?

The meaning here is more than merely, *Cupio ſcire quid facturus ſim, utrum moriar necne, num Amyntas ſemet perditurus ſit.* Even *Rogo, Jubeo, aliquem, mihi dicere quid faciam, quid debuero*

 facere,

facere, &c. does not fully expreſs it. The *energy* of interrogation, in point of thought, admits of a more cloſe and perfect combination with the conception denoted by a verb, than can well be expreſſed by any circumlocution *; but it is fully denoted by the interrogative mood, as appears by the perſon who is addreſſed in that mood returning a pertinent anſwer. This, which is ſo manifeſt with reſpect to the interrogative mood, is equally true with reſpect to all the other moods.

WONDER has a *kind of mood* appropriated to the expreſſing of it, made out by the addition of a particle, originally of interrogative meaning, to the indicative mood; at leaſt, I think it is ſo in all the languages that I am acquainted with.

> *Quam timeo quorſum evadas.* TER.

> *Quam pene furvæ regna Proſerpinæ,*
> *Et judicantem vidimus Æacum.* HOR.

> *Tela quam certo moderatur arcu.* SEN.

> *Qu'il eſt cruel—qu'il eſt doux d'etre Pere!*
> DIDEROT Pere de Famille.

> *How fearful and dizzy 'tis to caſt one's eyes ſo low!*

> *How many thouſands of my pooreſt ſubjects are at this hour aſleep!* SHAKES.

NONE of theſe ſentences are interrogations, or can admit of an anſwer. They all expreſs (in addition to the general meaning

* I BELIEVE the neareſt we can come to it is by the uſe of the imperative of a verb of affirming with the infinitive of the primary verb.

> *Dic mihi Damœta cujum pecus, an Melibœi?*
> *Cujus eſt pecus? Dic cujus pecus eſt.*
> *Jubeo te mihi dicere cujus pecus eſt.*

ing of the primary verbs) the emotion of wonder, or ſome mixed emotion, of which wonder forms a part. No perſon can doubt that this *energy* might have been expreſſed by inflection of the verb; and that, if it had been ſo, ſuch inflection *muſt* have been reckoned a perfect grammatical mood, and might have been reſolved, though no doubt but imperfectly, into a ſentence containing the primary verb, (*timeo*, *video*, &c.) and ſome verb, or phraſe containing a verb, expreſſive of wonder, or ſome ſimilar emotion. *Miror me tam pene vidiſſe regna Proſerpinæ, miror quantum timeo, mirus eſt timor meus, quorſum evadas.* I wonder, tremble, ſhudder, to caſt my eyes ſo low. I admire, it is admirable, that many of my ſubjects are at this hour aſleep.

WITH reſpect to the *grammatical mood* called the *ſubjunctive*, it muſt be obſerved, that it (like many words in common language) has different meanings, or expreſſes different *energies*, combined with the radical meaning of the verb, ſuch as, wiſh, (already conſidered) ſuppoſition, power, condition, *&c.* It muſt be in vain, therefore, to look for any one verb, or any one thought or energy, by means of which the ſubjunctive mood may uniformly be reſolved, as the indicative may be by *dico*, the optative by *opto*, the interrogative by *rogo*, the imperative by *jubeo*. It is to be reſolved occaſionally by means of different verbs, according to the particular energy or mood of thought expreſſed in any inſtance. Of this indeed there can be no better proof than the number of different auxiliary words which we employ in Engliſh to make out what we call the ſubjunctive mood in all its *tenſes*, ſuch as, *may*, *can*, *might*, *could*, *would*, *ſhould*, which are, by no means, ſynonymous and convertible terms, even in this application of them, and yet all correſpond occaſionally to the Latin ſubjunctive mood, which is ſimple, and only marked by inflection.

Crediderim, *poſſum credere*, I might believe; *credidiſſem*, *potui credere*, I might have believed. Condition, ſtipulation, ſuppo-

 ſition,

ſition, which, though ſomewhat different, are very near akin, are among the moſt frequent meanings of the ſubjunctive mood. This meaning, or mood of thought, may be reſolved, to a certain degree, into an imperative mood (the reſolution of which hath already been ſhewn) and the primary verb. An ingenious etymologiſt * has ſhewn, that the Greek particle ει, and the Roman *ſi*, are but contractions of certain parts or inflections of the ſubſtantive verbs, ειμι and *ſum;* which parts of thoſe verbs have an imperative meaning, *Be it ſo*. The ſame author ſhows, that our Engliſh particle *if* is juſt a contraction of the imperative of the verb *give*, anciently written and pronounced *gif*. *Si vis me flere*. *Sit*, *eſto*, *quod vis*, or *velis me flere*. *Fac*, *pone*, *te velle me flere*. The imperative *fac* was often uſed by the ancient writers of Latin in this ſenſe; *pone* ſeldom by them, but often by modern writers; τιθει was uſed in the ſame ſenſe by the Greeks. Indeed, different parts, both of τιθημι and of *pono*, were uſed for this purpoſe; the Romans, I preſume, imitating the Greeks. It is worthy of obſervation, that in French, the uſe of the conditional particle *ſi* superſedes completely the uſe, either of the ſubjunctive or of the conditional mood. *Si* in French always governs the indicative mood. *Si je peux*, *ſi je pouvois*, *ſi je pourrai;* never *Si je puiſſe*, *ſi je puſſe*, in the *ſubjunctive*, nor even *ſi je pourrois* in the *conditional mood*.

As to the circumſtance of being ſubjoined to a preceding member of a ſentence, and commonly to a verb in the indicative mood, from which the ſubjunctive has got its name, the difference of meaning between the ſubjunctive ſo employed, and that of the indicative in ſome caſes, and between it and the bare infinitive in others, is ſo minute, that it is difficult to aſcertain it, and perhaps impoſſible to expreſs it in words. Accordingly, we often find, that in tranſlating from one language into another, thoſe three grammatical moods *may* and perhaps

* Mr Horne Tooke.

perhaps *muſt* be interchanged, to preſerve the original meaning, without violating the idiom of the language into which the tranſlation is made. But the uſe of a peculiar inflection or mood to diſtinguiſh the ſecondary or ſubjoined verb from the fundamental or primary verb in a ſentence, often has its uſe; and I think, without much refinement, we muſt perceive an elegance, and perhaps too a greater degree of preciſion, in thoſe languages in which this nicety is attended to, as in Latin and in French; for in our own it is almoſt loſt ſight of. But it muſt be obſerved, that it is not every verb ſubjoined to another by the relative pronoun *qui*, that is put in the ſubjunctive mood. In many caſes, either the indicative or the ſubjunctive may be employed, almoſt indiſcriminately, both in Latin and in French. But ſometimes the one, ſometimes the other, ought to be uſed. Where the affirmation is certain and poſitive, the indicative ſhould be ſubjoined to the indicative.

—— *Heu quoties fidem,*
Mutatoſque deos FLEBIT: *et aſpera*
Nigris æquora ventis
EMIRABITUR *inſolens,*
QUI *nunc te* FRUITUR *credulus aurea:*
QUI *ſemper vacuam, ſemper amabilem*
SPERAT, *neſcius auræ*
Fallacis: miſeri, QUIBUS
Intentata NITES.

Cependant je RENDS *grace au zele officieux,*
QUI *ſur tous mes perils vous* FAIT *ouvrir les yeux.*

Jeune et vaillant heros, DONT *la haute ſageſſe*
N'EST *point le fruit tardif d'une lente vieilleſſe.*

Though in theſe lines of BOILEAU, there be no verb but *eſt*, IT is plainly ſubjoined to the preceding member of the ſen-

tence

tence by means of the relative *dont*. *Ne ſoit point le fruit*, would, in the firſt place, be bad French, and, in the next place, would have been a very impertinent inſinuation to LOUIS XIV. as if his high wiſdom had been ſomehow contingent, or hypothetical. But BOILEAU was not a man likely to fall into either of theſe errors.

ON the ſame principle, I preſume, the indicative mood is ſubjoined to the indicative, in the following paſſage of the Holy Scripture: *Je ſuis l'Eternel ton Dieu, qui t'* AI *tiré du pais d'Egypte, de la maiſon de ſervitude*. The ſubjunctive mood, *Qui t'* AYE *tiré*, would manifeſtly be inelegant and inaccurate in this place, where the ſubjoined affirmation is poſitive and certain. And for the ſame reaſon, we ſhould never heſitate to expreſs the ſame thought in Latin by the words, *Ego ſum Dominus tuus Deus, qui* EDUXI *te e terra Ægypti, e domo ſervitutis;* and ſhould be ſenſible of a groſs impropriety, if the word *eduxerim* were ſubſtituted for *eduxi*.

BUT in innumerable inſtances, wherein the ſubjoined verb expreſſes any thing uncertain, precarious, contingent, or dependent on the will or power of another, it is put in the ſubjunctive mood: hence this mood has, in all its *tenſes*, a ſort of affinity or relation to a *future* meaning. Still, however, great latitude is allowed to writers, both in proſe and verſe, and is actually taken by the beſt of them, in the uſe of the indicative and of the ſubjunctive moods; as in the following inſtances from VIRGIL and CICERO.

> QUID FACIAT *lætas ſegetes*, QUO SIDERE *terram*
> *Vertere, Mæcenas, ulmiſque adjungere vites*
> CONVENIAT: QUÆ CURA *Boum*, QUI CULTUS *habendo*
> SIT *pecori, apibus quanta experientia parcis,*
> *Hinc canere incipiam.*

Vos,

—— *Vos, O clariſſima mundi*
Lumina, labentem cœlo QUÆ DUCITIS *annum,*
Liber, et alma Ceres; veſtro ſi munere Tellus
Chaoniam pingui glandem MUTAVIT *ariſta,*
Poculaque inventis Acheloia MISCUIT *uvis:*
Munera veſtra cano. Tuque O CUI *prima frementem*
FUDIT *equum magno tellus percuſſa tridenti,*
Neptune: et cultor nemorum CUI *pinguia Ceæ*
Ter centum nivei TONDENT *dumeta juvenci.*

Enumerare poſſum QUÆ SIT *in figuris animantium, et quam ſolers ſubtiliſque deſcriptio partium, quamque admirabilis fabrica membrorum. Omnia enim* QUÆ *quidem intus incluſa* SUNT *ita nata, atque ita locata ſunt,* UT *nihil eorum ſupervacaneum* SIT, *nihil ad vitam retinendam non neceſſarium.*

CUJUS *quidem adminiſtratio nihil* HABET *in ſe* QUOD *reprehendi* POTEST; *ex iis enim naturis* QUÆ ERANT, QUOD *effici* POTUIT *optimum effectum eſt: doceat ergo aliquis potuiſſe melius: ſed nemo unquam docebit: et* SIQUIS *corrigere aliquid* VOLET, *aut deterius faciet, aut id, quod fieri not* POTEST, *deſiderabit.*

IN theſe paſſages, the ſubjoined verbs are marked in capitals. They are to the number of ſeventeen; yet of them no leſs than twelve are put in the indicative mood. And it may be obſerved, at leaſt with reſpect to the two paſſages from CICERO, that the meaning expreſſed by the ſubjoined indicative is not diſtinguiſhable, in ſeveral caſes, from that which, in other caſes, is expreſſed by the ſubjunctive mood.

THESE more particular obſervations, and the well known general fact, that, in our own language, we find means to diſpenſe with the uſe of a peculiar grammatical mood, to denote barely the circumſtance of being ſubjoined, I apprehend coincide perfectly with the account given of the comprehenſive and various meanings of that grammatical mood which is called

called the ſubjunctive, and amount to a full confirmation of that account.

II. The ſecond of thoſe concluſions can ſcarce require any explanation or commentary. The modification or mood of thought, which is moſt commonly expreſſed by a grammatical mood of a verb, is unqueſtionably that of affirmation, under which we may comprehend negation, or elſe we muſt uſe the more general term *propoſition*, which comprehends them both. This is expreſſed by the indicative mood. Next to this, the moods of thought, moſt commonly expreſſed by verbs, are thoſe of command and of interrogation; the latter (at leaſt in all the languages that I know any thing of) being *uſually* expreſſed, either by the addition of ſome particle to the common indicative mood, or elſe by ſome peculiar arrangement of the words connected with a verb in that mood. *Vidiſti, Thou ſaweſt* or *thou didſt ſee. Vidiſtine? Saweſt thou*, or *Didſt thou ſee?* Sometimes, however, it is not expreſſed in either of theſe ways, nor in any way but merely by the tone of voice of the ſpeaker; and conſequently, when it is written, and read ſilently, it cannot be diſtinguiſhed from a propoſition. *Fervet avaritia pectus. Laudis amore tumes.* Hence the uſe of points or marks of interrogation in writing. The former (command) is commonly expreſſed by a diſtinct grammatical mood.

These three moods are all plainly ſocial modifications of thought. No man could be ſuppoſed even to *form* (not to ſay *utter)* a propoſition, a queſtion, or a command, who did not believe that there were other intelligent Beings beſides himſelf, who might underſtand him. In general too, (for I admit there may be exceptions to this) the perſon who utters a propoſition wiſhes to be believed, he who gives a command wiſhes to be obeyed, he who puts a queſtion wiſhes to be anſwered, and all of them wiſh to be underſtood. Theſe are all operations of thought,

thought, which cannot be ſuppoſed to take place in a ſolitary Being.

But there are ſome moods of thought denoted by the grammatical moods of verbs, (more or leſs perfectly) which are not, ſtrictly ſpeaking, ſocial acts of the mind; for inſtance, wiſhing, ſuppoſing, wondering. Theſe may all be ſuppoſed to take place in a ſolitary being, like Robinson Crusoe in his iſland, as well as in Cicero in the Forum of Rome.

The greateſt part, even of common converſation, conſiſts of *propoſitions;* and whole volumes, both in hiſtory and in ſcience, may be, and perhaps have been written, conſiſting entirely of propoſitions, and of courſe requiring no other mood but the indicative.

But in common converſation, and ſtill more remarkably in all buſtling and intereſting ſcenes, commands and queſtions muſt occur, and, of courſe, the interrogative and imperative moods, however formed and marked, become neceſſary.

Next to theſe purely ſocial acts of the mind, or poſſibly not leſs frequent or important even than them, is the familiar and intereſting emotion of wiſhing. And this emotion or energy of thought we often have occaſion to expreſs or communicate to thoſe among whom we live and with whom we converſe; ſo that although it be not of itſelf, ſtrictly ſpeaking, a ſocial act of the mind, yet it is plainly very near akin to one, and may almoſt be ſaid to become one when combined with that of affirmation, as it is when expreſſed by the optative mood in common diſcourſe; for it would not be ſo in ſoliloquy. Now, theſe are the modifications of thought, which, in moſt languages that are tolerably perfect, are expreſſed by grammatical moods in one way or another.

III. The third concluſion, " That the grammatical moods " of verbs are conciſe modes of expreſſing the moſt frequent " modifications of thought, (and the moſt important or in-

" tereſting of them)" is ſelf-evident, when we compare them with the circumlocutions into which it is thought they may be reſolved. But it will be illuſtrated more fully than is neceſſary here, in conſidering the two laſt concluſions.

IV. As to the fourth concluſion, it muſt be very plain to us all, from the experience we have had of different languages, that none of them are in every reſpect, nay hardly in any reſpect, abſolutely perfect; and correſponding, either by the variety of words which they afford, or by the modifications, inflections, and arrangements of thoſe words, to all the varieties and niceties of human thought. It is only the moſt common and familiar thoughts or notions that have particular words in all common languages to denote them, and only the familiar and frequent combinations of thoughts that have appropriated phraſes to expreſs them. New notions require new words to denote them, as new combinations of thoughts, of which the variety is endleſs, require new phraſes and ſentences. In this way, languages gradually improve, at leaſt in point of richneſs, copiouſneſs, and preciſion.

But it is only the moſt frequent of all combinations of thought with that which is the general meaning of a verb, ſuch as affirmation, interrogation, command, wiſh, &c. that are expreſſed by ſuch inflections or variations of the primary verb, as may be called grammatical moods. Theſe are the combinations of thought, in the expreſſing of which, circumlocution, or tediouſneſs of any kind, would be the moſt diſagreeable and inconvenient; and for which, therefore, a quick and ſimple mode of communication is moſt requiſite. Many other combinations of thoughts may be expreſſed by the combination of different verbs with ſufficient quickneſs, and without inconvenience or diſagreeableneſs of any kind. The number of grammatical moods cannot be infinite. It is plainly limited, partly by the difficulty of contriving a great number of diſtinct inflections,

flections, partly too from the obvious difficulty of remembering and employing accurately even ſuch a number as might undoubtedly be contrived, but much more from there being no urgent occaſion for ſuch a variety of them; many of the combinations of thoughts to be expreſſed by verbs being ſo near akin, that they would naturally be claſſed together, and might be denoted by one grammatical mood, without danger of any ambiguity or obſcurity; as for inſtance, the various moods of thought which are occaſionally expreſſed by the grammatical imperative, or by the future tenſe of the indicative; all the diſtinctions of which moods of thought, both in kind and in degree, may be fully underſtood by thoſe to whom the diſcourſe is addreſſed, from a variety of well known or obvious circumſtances. Hence I think it appears very natural, that though the poſſible number of grammatical moods be very great, (though by no means infinite) the number of actually ſubſiſting moods in different languages ſhould be very ſmall; and that ſome, even of theſe few, ſhould occaſionally be employed with little diſtinction; the ingenuity and labour of mankind in contriving, and their preciſion and ſteadineſs in employing ſuch moods, being chiefly regulated by the experience of what they daily had occaſion for.

V. The fifth of thoſe concluſions reſpecting the importance of grammatical moods towards the perfection and beauty of language, by the quickneſs, animation, and force, which they give to the expreſſion of our moſt familiar and moſt intereſting modifications of thought, can require no other proof but mere illuſtration by proper examples, any number of which may eaſily and readily be found. And from theſe it will plainly appear, that the moods of verbs are in a manner eſſential to eloquence of almoſt every kind. "L'éloquence" (as M. D'Alembert very juſtly obſerves, and propoſes to define it) "eſt le "talent de faire paſſer avec rapidité, et d'imprimer avec force,

" dans l'ame des autres, le ſentiment profond dont on eſt péne-
" tré. Cette definition convient à l'éloquence même du ſilence,
" langage energique et quelquefois ſublime des grandes paſ-
" ſions ; à l'éloquence du geſte, qu'on peut appeller l'éloquence
" du peuple, par le pouvoir qu'elle a pour ſubjuguer la multi-
" tude, toujours plus frappée de ce qu'elle voit que de ce qu'elle
" entend ; enfin à cette éloquence adroite et tranquille, qui ſe
" borne à convaincre ſans emouvoir, et qui ne cherche point à
" arracher le conſentement, mais à l'obtenir. Cette dernière
" éſpece d'éloquence n'eſt peutêtre pas la moins puiſſante ; on
" eſt moins en garde contre l'inſinuation que contre la force."
D'ALEMBERT *Diſcours à l'Academie Françoiſe, et Reflexions ſur l'Eloquence Oratoire. Melanges*, Vol. II. p. 304, 305. 319.

OF all the moods of thought which are commonly expreſſed by grammatical moods, the indicative (comprehending the ſimple *ſubjunctive)* though one of the moſt important, and moſt frequently employed, is plainly one of the leaſt animated or intereſting, from the nature of the thought expreſſed by it, which is merely propoſition, that is, affirmation and negation. Though animation and force be little needed, yet brevity and quickneſs are of much conſequence in the expreſſing of this combination of thoughts. Had we not an indicative mood to expreſs it briefly, and in one word, our converſation and writing would be intolerably ſlow and tedious, and conſequently feeble and diſagreeable. We ſhould be obliged to employ at leaſt two verbs inſtead of one, and after all ſhould have but a very inaccurate and clumſy expreſſion of a thought, which we ſhould wiſh to communicate as preciſely and diſtinctly as poſſible. *Fuit Ilium* could not be reſolved into *Dico Ilium fuiſſe;* for *dico* is itſelf an indicative, reſolvable in the ſame way with *fuit; aio, inquam, aſſero, aſſevero, &c. me dicere.* Without the uſe of grammatical moods, we could get no nearer to a reſolution of *fuit Ilium* than *ego dicere fuiſſe Ilium.* Or dropping the inflections which ſerve to diſtinguiſh the infinitives from the

moods,

moods, properly ſo called, and taking only the roots or baſes of the verbs reſpectively, *Ego dic— fu— Ilium.* Any perſon may eaſily try the effect of ſuch a reſolution of any plain elegant compoſition, either in proſe or verſe, wherein the indicative and ſimply ſubjunctive moods are chiefly or ſolely employed; as for inſtance, the following beautiful lines of OVID, containing an account of PYTHAGORAS.

Vir FUIT *hic ortu Samius: ſed* FUGERAT *una*
Et Samon et dominos; odioque tyrannidis exul
Sponte ERAT: *iſque licet cœli regione remotus*
Mente deos ADIIT: *et quæ Natura* NEGABAT
Viſibus humanis, oculis ea pectoris HAUSIT.
Cumque animo, et vigili PERSPEXERAT *omnia cura,*
In medium diſcenda DABAT: *cœtumque ſilentum,*
Dictaque mirantum, magni primordia mundi,
Et rerum cauſſas, et quid Natura, DOCEBAT:
Quid Deus; unde nives; quæ fulminis ESSET *origo:*
Juppiter, an venti, diſcuſſa nube TONARENT:
Quid QUATERET *terras; qua ſidera lege* MEARENT;
Et quodcunque LATET. *Primuſque animalia menſis*
ARCUIT *imponi: primus quoque talibus ora*
Docta quidem SOLVIT, *ſed non et credita, verbis.*

IN theſe fifteen lines, there are ſixteen verbs, either in the indicative or in the ſimply ſubjunctive mood. Without the uſe of ſuch a mood, the thoughts expreſſed in the lines, ſimple and eaſy of apprehenſion as they may appear, could hardly have been expreſſed intelligibly; or if this, with much labour and ingenuity, could be accompliſhed, ſtill the beauty, the charm, of the compoſition would be completely loſt. The poet, the orator, the philoſopher, the hiſtorian, and indeed every perſon who has the gift of ſpeech, or who makes uſe of language in any way, has almoſt conſtant occaſiou to employ that mood,

and

and muſt ſeverely feel the want of it, whatever reſolution or circumlocution he might contrive inſtead of it. It is evident, that, in many caſes in real life, a ſlow and tedious expreſſion of the thought denoted by the indicative mood, ſuppoſing that it could be made ſufficiently intelligible, would not only be diſagreeable, but might ſcarce ſerve the purpoſe required; it might come too late. In certain circumſtances, a perſon's life and fortune may depend on his quickneſs in expreſſing what he means to communicate. Even where nothing of that kind is at ſtake, the difference between a quick and a ſlow tedious expreſſion of thought, is very ſtriking and important. Language is at beſt, and after all its improvements, not only leſs perfect and accurate, but incomparably ſlower, than thought; the quickneſs of which is proverbial, and with great reaſon. I believe it is even in many caſes much quicker than we are commonly aware of. We all know, that we can, in a very few ſeconds, recollect a vaſt number of things in ſucceſſion; ſuch as the various circumſtances of a ſtory, in which perhaps many different perſons were concerned, and many different events occurred, or the various ſcenes through which we paſſed in the courſe of a long journey. But to tell ſuch a ſtory intelligibly, or to deſcribe particularly ſuch ſcenes, even with the help of the moſt perfect language, might be the work of hours. In a certain ſtate of imperfect ſleep, in which dreams moſt commonly occur, or at leaſt are moſt diſtinct and beſt remembered, the train of thought appears to be incomparably quicker than we can ever make it, while awake, by any voluntary exertion. There is reaſon to think, that ſometimes a ſudden noiſe, which, to a careleſs obſerver, might ſeem to waken a perſon inſtantaneouſly and perfectly, may yet give occaſion to a *long* dream, in an almoſt imperceptible interval of time. I call the dream *long*, though it may paſs in a ſingle ſecond or leſs, when it conſiſts of a great or numerous ſeries of imaginary events, the narration of which would be long in point

point of time; like the adventure of the Sultan in the Arabian Nights Entertainments, who, on dipping his head into water, had a long and vexatious ſeries of adventures, for ſeven years, as he thought, in the ſhort ſpace of time in which his head was in the water. Even when we are awake, a voluntary train of thought, eſpecially when much connected with emotion or paſſion, is ſometimes ſo quick that we are unable to expreſs it in words, or at leaſt to do it any juſtice in point of quickneſs. Before we can expreſs even the hundredth part of it, the reſt of it is gone, and cannot be recalled but ſlowly, and with much labour. We can often obſerve, both in common converſation, and in public ſpeaking, that a perſon hath gone on much farther in thought than he has expreſſed in words. Many people cannot tell to any purpoſe either a ludicrous or a pathetic ſtory for laughing or weeping. The whole train of thought ruſhes on their minds ſo quickly as to overpower them with its full effect, before they have expreſſed enough to let their hearers know any thing of it, nay ſometimes before they begin to ſpeak.

Format enim natura prius nos intus ad omnem
Fortunarum habitum: juvat aut impellit ad iram,
Aut ad humum mœrore gravi deducit et angit:
Mox effert animi motus interprete lingua.

Some of the moſt intereſting modifications of thought, I mean emotions and paſſions, expreſs themſelves by natural language, that is by the countenance, voice and geſture, almoſt as quickly as they are conceived; and when they are expreſſed in this way, they are not only well underſtood by others, but are often in ſome meaſure communicated to them. For ſuch is the nature of man, that, independently of all religious precepts, and of all moral conſiderations, we are ſtrongly, and often irreſiſtibly diſpoſed to rejoice with thoſe that do rejoice,

joice, and weep with thoſe that weep. This we muſt all have ſeen, and to a certain degree felt, even in common converſation. We can often obſerve, that one very cheerful, or one very melancholy perſon quickly communicates his ſtate of mind to a whole company. We feel the ſame to a ſtill greater degree in ſcenes of real diſtreſs, or of violent emotions of any kind, and often to a very high degree from exquiſite theatrical repreſentation. The ſame principle extends to the ſpreading of the military ardour or of a pannic among ſoldiers, of civil fury among a mob, and of religious fanaticiſm, ſometimes even among people who did not apprehend any ſuch danger to themſelves.

NEXT to this inſtantaneous and moſt effectual expreſſion and communication of thought by natural language, is the quick tranſmiſſion of it by very brief expreſſions in artificial language. The beauty and force (that is, the quick, and powerful, and pleaſing, effect) of ſuch quick and brief expreſſions has been generally acknowledged, and felt, and admired. The chief, and ſometimes perhaps the only merit of certain apophthegms, or good ſayings, conſiſts in the brevity, and conſequently force of the expreſſion *. Among the Spartans, this ſtyle of ſpeaking and writing was ſo much admired as to become a matter of ſtudy, and conſequently ſometimes of affectation. It is certain, that many thoughts, which appear ſtriking and admirable, when expreſſed in one or two words, are feeble and frivolous, when expreſſed at full length, eſpecially when put into pompous language. On the ſame principle too, we may underſtand how it comes to paſs, that brevity, and the employment of few and ſimple words, are eſſential to the ſublime in literary compoſition; which is a well known and important fact.

WE are ſo apt to be diſguſted with a very full and preciſe expreſſion of thought, eſpecially on ſubjects which are familiar to

* Videſis PLUTARCH's Apophthegms.

to us, or at leaſt are ſuppoſed to be ſo, that many people who are accuſtomed to the elegant, and often conciſe and animated, compoſitions of hiſtorians, orators, and poets, cannot be reconciled to that accurate enunciation of propoſitions and of arguments in proof of them, which is often indiſpenſibly neceſſary for ſtrict reaſoning; or if they can bring themſelves to liſten to the propoſitions and demonſtrations of geometry, when expreſſed in this way, they will not ſo readily admit that there is the ſame occaſion for ſuch fulneſs and accuracy of expreſſion on any other ſubject, not even in metaphyſics; hence the vague, inconcluſive, and often abſurd reaſonings, which have produced both diſguſt and diſtruſt of ſuch ſpeculations.

Grammatical language, in general, and eſpecially the modern languages, afford ſuch ſlow expreſſions of thought, that often before we have heard or read the half of a ſentence, we apprehend the meaning of the whole of it, and, of courſe, the latter part of it is not merely ſuperfluous and tedious, but in many caſes quite diſguſting.

If we could expreſs our thoughts by grammatical language as quickly and conciſely as we can by natural language, and without loſing any thing of that diſtinctneſs and preciſion which artificial language gives to the expreſſion of them, it would unqueſtionably be a great improvement in language, in point of agreeableneſs, animation, and force. I doubt whether it would be equally favourable in ſcience. I am diſpoſed to think that the ſlowneſs, or even tedíouſneſs, of the expreſſion of our thoughts on certain ſubjects of profound reaſoning, has its uſe, by giving us time and opportunity, and almoſt forcing us, to attend to every particular thing, and its relations to other things, about which we reaſon. But even this has its limits; and mathematical demonſtration itſelf, as we find it in the writings of the ancient geometers, is but an abridged chain of ſyllogiſms. And it is ſtill further abridged in many caſes, by thoſe who are perfect maſters of it, by omitting many of

the more minute and eafy fteps which thofe who are well accuftomed to fuch reafonings quickly and eafily fupply for themfelves, and find pleafure in this quicknefs and brevity; while, on the contrary, they are tired and difgufted with that flow and tedious expofition of every ftep in the reafoning, which to them is needlefs, but perhaps would be neceffary for the inftruction of thofe of inferior talents and knowledge.

A GRAMMATICAL language, as quick as thought, and as concife as natural language, is manifeftly unattainable. But every approximation to it is valuable. All the moods of verbs, even the indicative and the fimple fubjunctive, are fuch approximations.

IF thefe obfervations be true, with refpect to the indicative and fimply fubjunctive mood, and the plain and tranquil expreffion of mere propofition, how much more important and ftriking muft the correfponding differences be, between the concife and quick expreffions of fuch interefting and animated combinations of thoughts, as interrogation, command, wifh, *&c.* by the grammatical moods of verbs, and the flow, languid enunciations of the fame or fimilar thoughts, by circumlocution and the ufe of additional verbs?

THERE is a juft and beautiful obfervation of LONGINUS, relating to this fubject, which will fairly admit of much more extenfive application than he has made of it, and is in truth more important than he feems to have been aware of. He takes notice of interrogation as a figure of rhetoric, by which an orator endeavours to render the expreffion of his thoughts more animated and forcible. Τι δ' εκεινα φωμεν τας πευσεις τε και ερωτησεις; αρα ουκ αυταις ταις των σχηματων ειδοποιΐαις παραπολυ εμπρακτοτερα και σοβαρωτερα συντεινει τα λεγομενα; LONGINUS *de Sublim.* Sect. xviii. This opinion he illuftrates, in fome meafure, by the manner in which he expreffes it, namely, by the ufe of the very figure of interrogation of which he is treating; and ftill better by a very apt quotation from the firft Philippic

of

of DEMOSTHENES. Η βȣλεσθε, ειπε μοι, περιιοντες αλληλων πυνθανεσθαι κατα την αγοραν, λεγεται τι καινον; γενοιτο γαρ αν τι καινοτερον, η Μακεδων ανηρ Αθηναιους καταπολεμων, και τα των Ἑλληνων διοικων; τεθνηκε Φιλιππος; ου μα Δι' αλλ' ασθενει· τι δ' ὑμιν διαφερει; &c.

THE juſtneſs of LONGINUS's remark on this paſſage, and indeed his general obſervation with reſpect to the animation and force of interrogation, employed as a figure of rhetoric, can, I think, admit of no diſpute. But even the truth of it, and our ready acquieſcence in it, implies that he was, and that we too are, ſenſible of ſomething more animated and forcible in an interrogation, even literally employed, as in common life, than in a circuitous expreſſion of the ſame thought; elſe it never could have been employed, nor thought of, as an animated figure of ſpeech.

EVEN the ſimple interrogation, *Who is that?* is evidently more animated and forcible, as well as more conciſe, than *I deſire you to tell me who that is*, or *I deſire to be informed who that is.* The ſame is equally obvious with reſpect to *go*, *come*, *do this*, *te ſpectem*, *te teneam*, ὑμιν μεν θεοι δοιεν, if we compare them with *I order you to go*, *I command you to come*, *I deſire you to do this*, *cupio te ſpectare*, *opto te tenere*, λισσομαι τȣς θεȣς ὑμιν διδοναι, or, λεγ— λισσ— θεȣς ὑμιν δο—; which is employing merely the roots, without any inflection whatever of the three verbs, the meaning of all of which, to wit, affirmation, wiſh, and giving, is briefly, but fully and clearly, and conſequently forcibly expreſſed by the Greek optative δοιεν.

THE more urgent the occaſion is, and the more intereſted the paſſions become, the more important is the brevity and force of theſe moods to the expreſſion of our thoughts. This, which is obvious even in common life, is ſtill more ſtriking in thoſe animated and intereſting repreſentations of real life, which we have in dramatic poetry; to a great part of which it may fairly be ſaid that theſe moods are eſſential.

 IN

In the great diſcovery ſcene in *Oedipus Tyrannus*, there are not fewer than 150 interrogative and imperative ſentences; any one of which would be murdered, and the effect of the ſcene ſpoiled, by uſing circumlocution by means of a verb of aſking or of commanding.

In the paſſionate ſcenes of *Lear* and of *Othello*, ſeveral hundreds of ſimilar inſtances may eaſily be found.

In the diſcovery ſcene in *Douglas*, ſome of the fineſt ſtrokes of paſſion, of anxiety, of wonder, of horror, of eager curioſity, are conveyed by means of the moods of verbs, and would be loſt in any circumlocution.

Was he alive?
—— Inhuman that thou art
How couldſt thou kill what winds and tempeſts ſpared?

Even Rowe, amidſt all his golden verſe, was not unmindful of the force and animation which the moods of verbs give to the expreſſion of thought.

—— Does he? Does Haſtings?

Reward him for the noble deed, juſt Heaven.

For this one action, *guard* him, and *diſtinguiſh* him,
With ſignal mercies, and with great deliverance;
Save him from wrong, adverſity, and ſhame;
Let never fading honours *flouriſh* round him;
And *conſecrate* his name even to time's end;
Let him know nothing elſe but good on earth,
And everlaſting bleſſedneſs hereafter.

The poor, forſaken, royal little ones!
Shall they be left a prey to ſavage power?
Can they lift up their harmleſs hands in vain,
Or *cry to Heaven* for help, and not be heard?
Impoſſible!

Go

Go on, purſue, aſſert the ſacred cauſe, *ſtand forth* and *ſave.*—— *Jane Shore, act* 4. *ſc.* 1.

Alas! *I never wrong'd you*—
Oh! then *be good* to me, *have pity* on me;
Thou never knew'ſt the bitterneſs of want,
And *may'ſt thou never know it.* Oh! *beſtow*
Some poor remain——
Allow me but
The ſmalleſt pittance. *Act* 5.

THE genius of SOPHOCLES and of SHAKESPEARE, and the talents of GARRICK and SIDDONS united, could not make ſuch ſentiments as thoſe of *Lear*, and *Othello*, and *Oedipus*, and *Lady Randolph*, and *Jane Shore*, intereſting, or even tolerable, to any reader or ſpectator of taſte and judgment, if they were expreſſed in minute detail, by ſuch circumlocutions as the grammatical moods of verbs may be reſolved into.

THE fineſt inſtance that can be given, or indeed ſuppoſed, of the truth of this principle, we have in HOMER, in the admirable ſpeech of *Priam* to *Achilles*, when he goes to beg the body of his ſon *Hector*. This ſpeech has been univerſally admired, as perhaps the moſt eloquent that ever was compoſed. Though it be exquiſite in every part, the exordium, and indeed the very firſt ſentence of it, is by far the moſt ſtriking and eloquent part of it. This too HOMER ſeems to have felt and underſtood perfectly; for he makes *Priam* repeat the ſame thought, and almoſt in the ſame words, at the end of his ſpeech, by way of peroration, and with a very happy effect. When *Priam* enters the tent of *Achilles*, and throws himſelf at his feet, his addreſs to him is moſt ſingularly ſtriking.

Μνησαι πατρος σειο θεοις επιεικελ' Αχιλλευ,
Τηλικε ὡσπερ εγων, ολοῳ επι γηραος ουδῳ.

Think

Think of thy father, O god-like Achilles, old like me, and on the brink of the grave. Poſſibly there is a force and propriety in the uſe of the aoriſtic imperative μνησαι, inſtead of the preſent imperative, which would be more intelligible to HOMER's countrymen than it can be to us. Perhaps to them the difference between thoſe two forms of the imperative mood might be as great as it is to us between *think of* and *be thinking of*, the imperative of the aoriſt being a more vehement, ſudden and urgent requeſt or command than the imperative preſent μναου, but yet not diſreſpectful, like the imperative perfect μεμνησο, which, I believe, might be addreſſed to a ſlave, but could not, with propriety, be employed by a ſupplicant to an equal or to a ſuperior.

SOME nicety and delicacy of this kind ſeems to be expreſſed in the concluſion of *Priam's* ſpeech, by the uſe of the imperative preſent of one verb, and the imperative of the aoriſt of another, in the ſame line.

> Αλλ αιδειο θευς Αχιλευ, αυτον τ' ελεησον,
> Μνησαμενος σϋ πατρος·

Αιδειο, αιδου, αιδεου, is the imperative preſent of αιδεομαι; ελεησον is the imperative of the aoriſt of ελεω. The former ſeems a more tranquil and cool requeſt, or rather advice or ſuggeſtion, and refers to a continued, or frequently repeated, action, ſtate, or habit, to wit reverence to the Gods. The latter is a more urgent ſupplication for immediate pity and favour; as if he had ſaid, *Be ever mindful of your duty to the Gods, and inſtantly* (or *at this time, moment, &c.) have pity on me.*

WHATEVER may be thought of theſe ſpeculations and refinements, it can never be doubted, that if, inſtead of the imperative mood, we were to uſe a circumlocution, to expreſs the warm and vehement ſentiments of *Priam*, it would be inſupportable; λισσομαι σε μνησασθαι σϋ πατρος—αιδεισθαι τυς θευς—αυτον ελεησαι. Such a ſlow and languid expreſſion would have

ſuited

fuited ill with thofe fentiments and actions which HOMER attributes to *Priam.* Indeed his actions, without his fpeaking at all, would have been more pathetic and perfuafive than they would have been with fuch imperfect and improper expreffions of his thoughts; but by means of the moods of verbs, it is poffible to unite, to a certain degree, the advantages both of natural and of artificial language.

WE have many inftances in poetry, as well as in oratory, of the *figurative* ufe of fuch moods as I have juft now been confidering, and the effect of it, in enlivening and enforcing the expreffion of the poet's fentiments, is very ftriking.

Can ftoried urn, or animated buft,
Back to its manfion call the fleeting breath?
Can honour's voice provoke the filent duft?
Or flatt'ry footh the dull cold ear of death?

What female heart can gold defpife?
What cat's averfe to fifh? GRAY.

BUT while I thus point out how great a fhare the concifenefs of the expreffion of many thoughts, by means of grammatical moods, has in giving animation and force to language, I beg it may not be thought that I impute the animation and force of fuch expreffions *entirely* to that concifenefs. Many of the thoughts to be expreffed are in themfelves highly animated and interefting; and, on this very account, concifenefs in the expreffing of them is peculiarly agreeable, and even neceffary.

VI. THE fixth and laft conclufion refpecting the import of the moods of verbs, is very intimately connected with the preceding. It relates not merely to the brevity and quicknefs of the expreffion of thought, but to the intimate combination, and fimultaneous exhibition, of the figns of thoughts, which thoughts

thoughts are themſelves co-exiſtent, and moſt intimately combined. To this great property of thought, which has never yet been conſidered with that attention which it deſerves, inflections of words, and eſpecially the moods of verbs, do ſome kind of juſtice; while circumlocution of every ſort, even though it expreſs all the different thoughts, does manifeſt violence.

To explain this fully, would require a much longer and more elaborate diſquiſition concerning the nature of human thought than would be proper here. It may, however, be, in ſome meaſure, underſtood, by obſerving, that grammatical language, though the nobleſt of all human inventions, or, as ſome conceive, an art beyond the reach of our unaſſiſted faculties, and imparted to us by a kind of immediate inſpiration from Heaven, is, by no means, abſolutely perfect, nor even capable of ever becoming ſo. It anſwers admirably well for denoting many of our thoughts, either ſingly, or in various relations, particularly in ſucceſſion, and is even ſubſervient to the preciſion and ſteadineſs of thought, by the ſubdiviſion or decompoſition of the maſs of thought which it requires, and obliges us to make, not merely for the inventing, but for the learning, and the occaſional uſing, of language. It is indeed in many ways the chief inſtrument in the improvement of human reaſon. But in one very important reſpect, it is almoſt incongruous with the nature of that thought which it is employed to repreſent.

THE artificial ſigns, whether audible or viſible, that we uſe in grammatical language to denote our thoughts, are neceſſarily arranged, either in the order of time, or in that of place; and when we ſee the viſible ſigns arranged in the order of place, (as in reading) we attend to them, and occaſionally give them audible utterance in the order of time.

BUT our thoughts themſelves are not arranged in either of thoſe ways. It is ſelf-evident, that thoughts cannot be arranged in the order of place; at leaſt this will be ſelf-evident to every perſon

perſon who can ſhake off the long eſtabliſhed philoſophical hypotheſis of *ideas*, or images of things in the mind, as ſubſervient to thought; or even who will take the trouble to diſtinguiſh between ſuch ſuppoſed images, which, like thoſe of a magic lanthorn, may be conceived to be arranged in place, and the thoughts correſponding to them. And I believe it is equally certain, though not equally evident, that *many* of our thoughts are not even arranged in the order of time, but are related to one another in a very different manner, which is well underſtood, as being perfectly familiar to us, but which cannot be repreſented merely by the arrangement of words.

That *many* of our thoughts are arranged in the order of time, or, in other words, that there is a train or ſucceſſion of thought, is, I think, too evident and generally acknowledged to require either proof or illuſtration; and this relation among our thoughts may be fairly and completely repreſented by the ſucceſſion of audible words, and of courſe with ſufficient propriety by the arrangement of viſible words.

But this is perhaps the leaſt important of all the various relations of thought. Beſides the train or ſucceſſion of thoughts in time, there is often at once a great combination or maſs of thoughts variouſly related to one another. Such a maſs of thought we ſometimes wiſh to impart entire and all at once; ſometimes we wiſh to analyſe it, to break it down, as it were, and either to attend to it ourſelves, or to impart it to others, that they may attend to it, piece-meal.

For the latter purpoſe, the arrangement of words in grammatical language is admirably well adapted; for the former, it is in a great meaſure unſuitable. It gives disjointed, and in ſucceſſion, thoſe thoughts which we have united and ſimultaneous, and wiſh to communicate in the ſame way.

Hence the importance of the great principle of inflection in grammatical language, and its ſuperiority to mere arrangement of words: Hence too the ſuperiority of thoſe languages which, having many and diſtinct inflections, admit of great variety

of arrangement. This is ſcarce required for mere reaſoning, but is of great value in poetry and eloquence, not only in point of ſound, but ſenſe, both with reſpect to the force of it, and the juſtneſs of the expreſſion of the various complicated and ſimultaneous relations of the things conceived.

Now, to inflection the moods of verbs plainly belong; and by them we expreſs the ſimultaneous combinations of the thoughts or *energies* of affirmation, interrogation, wiſh, command, and many others, with the thought or *accident* expreſſed by any verb; and when we expreſs theſe combinations by reſolution or circumlocution, by means of two or more verbs, we, in ſome meaſure, ſeparate in words what was moſt intimately blended in thought, and repreſent as ſucceſſive what we conceived, and wiſhed to impart, as ſimultaneous.

THIS doctrine will not be admitted by thoſe philoſophers who have aſſumed or admitted as a principle, that a perſon can have but one thought (or *idea)* at once. But this principle I diſregard, as I know of no proof of it, and as it ſeems to me inconſiſtent with many obvious phenomena, and even repugnant to direct conſciouſneſs. I ſuſpect that it has been adopted in conſequence of very careleſs obſervation, both of thought and of language; and I think it of ſome conſequence to be aware of the error of ſuch an opinion; for though it may appear, at firſt view, of little importance, whether we admit the ſimultaneous preſence, or only the immeaſurably quick ſucceſſion of different thoughts, yet the difference of theſe two principles may be found very great, on tracing their ſeveral conſequences. With reſpect to the moods and other inflections of verbs, I cannot think it ſhould admit of doubt, that they are employed and underſtood to denote combinations of ſimultaneous thoughts, no one of which can reaſonably be ſaid to occur to the perſon ſpeaking, or to be apprehended by the perſon hearing, before the reſt. *Specto, ſpectemus, ſpecta, ſpectaverunt, ſpectavitne?* All nouns, even proper names, denote a congeries of circumſtances,

ſtances, or a *maſs* (not a *train*) of thoughts, which are conceived at once, and cannot be ſeparated and conſidered in ſucceſſion, but by a very laborious effort. Many ſingle words, for example prepoſitions, and moſt ſentences, denote ſome kind of relation; but we cannot, I think, conceive a relation, without thinking at once of the things (two or more) that are related, as well as of the relation (both in its generic and in its ſpecific nature) that ſubſiſts between them.

Mathematical propoſitions are expreſſions of co-exiſtent thoughts, the objects of which (at leaſt in pure geometry) bear no relation at all to time; and theſe, to be conceived rightly or at all, muſt be conceived at once. Any ordinary perſon can do this with reſpect to an axiom, or even a very ſimple propoſition; and good mathematicians can do it with reſpect to very long and complex theorems, ſome of which ordinary people find almoſt inſuperable difficulty in apprehending. Part of this difficulty (as I feel very plainly in myſelf) ariſes from the number of things and relations that are to be thought of at once, and accordingly is not immediately removed, nor is it obviated, by even the moſt diſtinct and juſt conception of every one of thoſe things and relations taken ſingly. Correſponding to this difficulty in a learner, and juſt the oppoſite of it, is that of a teacher of almoſt any ſcience, and often of a ſpeaker, either in a public aſſembly or in common converſation, who may have a clear and juſt conception of a great maſs of thought, which he wiſhes to communicate to others, but can ſcarce contrive to do ſo, nor knows he well where or how to begin; and perhaps when he has begun right, or at leaſt diſtinctly, ſoon falls into ſuch confuſion and perplexity, as makes him almoſt or quite unintelligible to his hearers, even when he underſtands himſelf perfectly, and may know that another, more fortunate in the talent of communicating thought, has *helped him out*, or expreſſed diſtinctly and properly that very meaning which he was endeavouring in vain to convey to his hearers,

 though

though as well acquainted as the other with the proper words to denote every portion or fragment of the great congeries of thought.

There is reaſon to think, that there are much greater differences among mankind, with reſpect to that capacity or comprehenſiveneſs of mind, by which they take in, or attend to, at once, a variety of objects and relations, than there are with reſpect to the conception or ſimple apprehenſion of any one of them by itſelf. And that comprehenſiveneſs of mind, which is in truth a moſt valuable talent, both with a view to ſpeculation and action, may be improved by various means, eſpecially by frequent exerciſe, and may be aſſiſted by many expedients.

A person who, when he firſt begins the ſtudy of mathematics, can apprehend only the axioms and the ſimpleſt propoſitions, after a few months or years employed in that ſtudy, will eaſily apprehend, not only the propoſition, but the demonſtration of complex theorems, which are maſſes of co-exiſtent thoughts, that could not be expreſſed by the ſucceſſion of words in leſs than ſeveral minutes, nor by the arrangement of words in leſs than ſeveral pages.

The ſucceſſion, and even the beſt arrangement of words are found ſo unſuitable for the expreſſion of ſuch combinations of thoughts as occur in many mathematical propoſitions, that other expedients are very generally and properly employed to aſſiſt us in making or in communicating theſe complex operations of thought.

Diagrams and algebraical formulæ anſwer theſe purpoſes admirably well. Neither of them, ſtrictly ſpeaking, is eſſential to mathematical demonſtration; but both of them are highly uſeful in it, and many good mathematicians would be at a ſtand if they were deprived of them. A good *conſtruction* or diagram will ſuggeſt inſtantaneouſly the whole congeries of thought which conſtitutes both the propoſition and the demonſtration of a theorem. A good *expreſſion* in algebra anſwers nearly the ſame purpoſe; and ſuggeſts, almoſt inſtantaneouſly, ſuch a maſs of thought, without confuſion, as never could have

have been conveyed by common words in ſucceſſion and arrangement, by reaſon of the great length of time required to utter or to read them; in the courſe of which time, many of the particular thoughts compoſing the maſs would be gone, before others were ſuggeſted or produced, with which they ought to be combined, to enable us to perceive their various relations.

THE analogy between the diagrams and formulæ of mathematicians, and the moods of verbs, and other inflections of words in common diſcourſe, which I endeavour here to point out, is not ſo diſtant as may at firſt ſight appear. They agree in this, that all of them expreſs, infinitely better than any ſucceſſion or arrangement of words can do, combinations of thoughts, which are almoſt or perfectly co-exiſtent, and which, by means of them, are apprehended more juſtly, more quickly, and more forcibly, than otherwiſe they could be.

AND let it be remembered, that the objects and relations which occupy the minds of geometers, though more abſtruſe, and requiring a greater voluntary effort of thought, than thoſe which engage the attention of ordinary men, are not more numerous or complicated, but in general much leſs ſo; and that they admit more eaſily, and with leſs injury, of being broken down, and given ſucceſſively, at leaſt with a view to demonſtration, in which no great quickneſs is required. Hence, in a great meaſure, the clearneſs and force of mathematical reaſoning.

THE maſſes of co-exiſtent thoughts which we often meet with in common diſcourſe, or in elegant compoſition *in full periods*, are of incredible extent, as appears on our endeavouring to analyſe them, and expreſs in detail the various parts of the complicated meaning which we apprehend.

THE firſt ſeven lines of the Iliad, containing about forty words, and the firſt ſixteen lines of Paradiſe Loſt, containing about one hundred and twenty words, denote reſpectively a maſs

maſs of co-exiſtent thoughts, not a train of ſucceſſive thoughts. The thoughts expreſſed in them are much more numerous than the words, as plainly appears on endeavouring to explain or define all the words, even in their moſt general radical meaning, which is rendered ſtill more complicated, that is, expreſſive of more thoughts, by the inflections of many of them, eſpecially in the Greek lines. We can attend to different parts of that maſs of thought, at our pleaſure, regardleſs of the reſt, or we may take in, more or leſs clearly, the whole at once, as the authors certainly did in compoſing the lines; or we may attend accurately to the meaning of every word ſingly. And if this be done very ſlowly, and with long intervals between every word, the meaning of the whole lines, as a ſentence or period, will be loſt; nor can we, in ſuch a way of reading or pronouncing HOMER's or MILTON's lines, make ſenſe of them, but by a voluntary and painful effort of memory, to retain, or recal, the former words and thoughts, till the latter are ſuggeſted and duly combined with them. The words of the fineſt period that ever was compoſed, when read or uttered one by one at the interval of a few minutes, or even ſeconds, will no more have the effect of the period properly read or uttered, in point of thought, than an equally ſlow ſounding of the various notes in a piece of muſic will have, in point of melody or harmony, the effect of the muſic properly performed; or than the ſucceſſive and ſlow inſpection of the different rainbow colours will have, in giving the perception of white, which they would give, if contemplated at once properly blended, or even if contemplated in very quick ſucceſſion.

AFTER all, perhaps the beſt illuſtration of this important principle is that of the Indian orator, mentioned in the Origin and Progreſs of Language, Vol. IV. p. 22. " I have heard a " ſtory" (ſays the learned author of that work) " of an Indian " orator, who, at a congreſs or *talk*, as they call it, with the " then Britiſh governor of Florida, Commodore JOHNSTON,

" being

" being frequently interrupted by the interpreter, who ſtopped " him in order to explain to the governor what he ſaid, at laſt " loſt patience; and, ſays he, *I can bear this no longer. My* " *diſcourſe, cut thus into pieces, can have no more effect than the* " *water could have on that great beaſt of yours,* (pointing to a " ſaw-mill at ſome diſtance) *if it were to fall upon it drop by* " *drop.* Now, this orator muſt have had as perfect an idea " of the *flumen orationis,* and the effects it produces, as a Ci- " cero or Demosthenes." The ſame author has many juſt and ſtriking remarks on the force, the beauty, and the *comprehenſiveneſs* of compoſition in periods, (page 239, 240.) and of inflection of words, (page 14. *et paſſim.*) And all of theſe obſervations may fairly be applied to the moods of verbs. What proper periods are to very great and complicated maſſes of thought, inflections, including moods, are to the more familiar and ſmaller combinations of thoughts, which we almoſt every moment experience, and wiſh to expreſs united as we conceive them.

* * * *

As I think it of eſſential importance, in all ſcientific inveſtigations, never to blend *hypotheſes,* or matters of opinion, with evident matters of fact, and ſtrict inferences by induction from them; it is proper to point out, that no hypotheſis whatever, with reſpect to the original ſtate, or the formation, or the improvement, of language, is aſſumed in this Eſſay.

It has generally been ſuppoſed, or taken for granted, in all reaſonings about the theory of language, that, in a very early period of its progreſs, perhaps from its very origin, it was rude and ſimple, almoſt deſtitute of inflections, (ſuch as the moods of verbs) and in a great meaſure or wholly monoſyllabic; and that all manner of inflections and modifications, by compoſition, by augment, or otherwiſe, were gradually given, in a ſlow progreſs, to thoſe monoſyllabic roots, by deliberate human contrivance.

That

THAT this has taken place, to a certain degree, in many languages, and to a very great degree in ſome, cannot be diſputed. In Greek, for example, we can, with the greateſt eaſe, refer ſome thouſands of *words* (counting every variation by inflection, by augment, or by compoſition, as a different *word)* to one ſimple root, ſuch as λεγ.

IN ſome languages, it ſeems probable that the uſual progreſs and improvement has not taken place, they remaining very long in a monoſyllabic ſtate. This has certainly been the caſe with the Chineſe language, for ſome thouſands of years; probably, in part at leaſt, the conſequence of that great, civilized and ingenious people perſiſting in the uſe of hieroglyphic characters, immediately ſignificant of thought, without any direct relation to audible words, like the Indian figures that we uſe in common arithmetic, and never adopting the noble invention of alphabetic characters, directly expreſſive only of ſounds, the combinations of which ſounds are immediately ſignificant of thought.

BUT ſome ingenious men have been of opinion, confirmed, as it is ſaid, by actual obſervations of the languages of ſome very rude nations, eſpecially in America, that ſome languages at leaſt, perhaps all, were, in a very early period, polyſyllabic to a moſt inconvenient degree; the words of them being very long, and ſignificant of very complicated meanings, like phraſes or whole ſentences of ours. It has been thought, that theſe unwieldy long words may have been gradually broken down into ſhorter, and even into monoſyllables; which, in a further progreſs, might be varied again by inflection and otherwiſe.

IT is certainly conceivable, and not very improbable, that mankind, in their firſt rude attempts towards forming a language, might not perceive the vaſt advantage to be gained by ſubdividing, and breaking down as it were, the great maſs of thought which they conceived, and wiſhed to communicate. They might attempt to give utterance by one word to all the maſs

mafs of thought which they had to exprefs. Thus, *Give me a bow*, might be expreffed by one word; *Give me food*, by another; *I faw a friend, an enemy, a beaft, a man, a woman*, by as many different words; no diftinction being made between noun and verb, agent or fubject, mood or accident. But the inconvenience of fuch a language would foon be felt and gradually remedied; and the firft and moft natural ftep would be to employ the fame word for *give*, whatever was to be given, one word for *fee*, whatever was feen, and to employ different *nouns* to denote the fubftances given or feen. But this implies the previous exercife of a faculty of a higher order than that of dividing the voice, or forming articulate founds. The fame power that has made us Μεροπες, hath alfo taught us to divide our thoughts. Indeed, without this nobler faculty, which feems to be denied to all the inferior animals, and is fcarce perceptible in man during the firft months of his life, the other would be of little value. Several animals have learnt to divide the voice, or to articulate, better than many unfortunate individuals of our own fpecies, who were deficient in the proper organs of voice and fpeech; but none of them have ever learned to make ufe of fpeech as we do. They probably always, and children for fome time, make no attempt to feparate or analyfe their thoughts. Till that be done, which our fuperior faculties foon enable us to do, the very fundamental notions of the parts of fpeech cannot be conceived, grammatical language cannot be contrived, nor even if it were prefented to us ready made, in all the perfection of the Greek of DEMOSTHENES, could it be either learned or employed.

ON the former fuppofition, (page 247.) the moods of verbs muft be conceived to be *added* to them in the courfe of the formation or improvement of language.

ON the latter fuppofition, they muft be conceived to be *retained* in language, and to be a remnant of a very rude polyfyl-

labic ſtate of it, which, though inconvenient on the whole, had ſome advantages.

Some *expreſſions* occaſionally employed in this Diſſertation, may ſeem to favour or to imply the former ſuppoſition. But that is not meant. Neither hypotheſis is aſſumed in the reaſoning. Thoſe expreſſions have always been employed with caution and diſtruſt, and merely in compliance with cuſtom, a deviation from which might have ſeemed to imply the oppoſite hypotheſis, and would have required a new, and, in ſome meaſure, an embarraſſed and uncouth mode of expreſſion.

Both hypotheſes are equally indifferent to this Theory of the Moods of Verbs, which is independent of all hypotheſes, and does not extend to the *hiſtory* of the firſt appearance of *moods*, nor to the queſtion, whether they be added to language in its progreſs, or retained in it when perhaps many other inflections were laid aſide. They may be partly both, or their hiſtory may be different in different languages. All that is attempted in this Theory of the Moods of Verbs, is only to inveſtigate the nature and import of them more accurately than had been done before, and to ſhew what valuable, and almoſt indiſpenſible purpoſes they actually ſerve in the communication of thought.

VII.

VII. *An* Essay *on the* Character *of HAMLET, in* Shakespeare's *Tragedy of* Hamlet. *By the Reverend Mr THOMAS ROBERTSON,* F. R. S. Edin. *and Minister of Dalmeny.*

[*Read by Mr DALZEL, Secretary, July* 21. 1788.]

THE *Character* of Hamlet, has been variously judged of by critics, and what might be expected, it has been still more variously represented by performers upon the stage. Shakespeare himself seems to have apprehended that this would happen; and that injustice would be done to a hero, who probably, in his estimation, ranked higher than any other that he has brought into the drama.

When Hamlet was dying, he appears, upon this account, to have made him speak as follows to Horatio.

—— Horatio, I am dead;
Thou liv'st; report *me* and *my cause* aright
To the unsatisfied.
Oh good Horatio, what a *wounded* name,
Things standing thus unknown, shall live behind me.
If thou didst ever hold me in thy heart,
Absent thee from felicity a while,
To tell my tale.

Hamlet was here in a situation in which men in general speak truth; and he was besides speaking to a confidential

 friend,

friend, who could not be imposed upon ; a friend who, from the strongest possible attachment to him, had been about to put an end to his own life, but was restrained from his purpose, in order to explain to a " harsh world," the story of HAMLET, after he was no more.

AND when HAMLET dies, HORATIO pronounces this eulogium :

> Now cracks *a noble heart!* good night, *sweet prince;*
> And flights of angels sing thee to thy rest.

SHAKESPEARE, in these passages, not only refers to the particular part which HAMLET had acted, with respect to the usurper, (which he calls HAMLET's *cause*) and which, upon being explained, would vindicate what he had done. He plainly intimates by the mouth of HORATIO, his own idea of HAMLET's character, in all other respects ; as not only heroic and splendid, but perfectly consistent, amiable and just ; and further, from the danger that HAMLET himself, as well as his cause, might be exposed to the censure of the unsatisfied, he seems strongly to insinuate, that the character could not be comprehended, unless an enlarged view were taken of it, and of the different situations in which it had been placed.

HAMLET's conduct in having put the king to death, was, in a great measure, already justified, in the very hearing of the lords, and other attendants upon the court, who were witnesses to it. The queen, who had just expired in their sight, had said she was " poisoned." HAMLET had called out " villany!" Even LAERTES, the treacherous opponent of HAMLET, had declared, " the king, the king's to blame—It is a poison tem-" pered by himself." And HAMLET, upon stabbing the king, had expresly charged him with " murder." All this passed in the presence of the court, who would hence be led to view the king as guilty of having poisoned the queen, and therefore as justly

juftly put to death by her fon. It is true indeed, the king had intended to poifon, not the queen, but HAMLET; but neither the court, nor HAMLET himfelf, knew this; none but LAERTES was privy to it; and as he immediately expired without faying more, the fecret was to laft for ever.

HAMLET, therefore, could have but little caufe to fear that he fhould leave a wounded name behind him for thus revenging his mother's death. What troubled him, was the thought that pofterity would condemn him for not having, before that time, revenged the murder of his father. This was the reproach with which he had often charged himfelf; for at the beginning he had refolved to act quite otherwife, and had expresfly promifed to his father's ghoft, with the utmoft fpeed to avenge the murder.

> Hafte me to know it (faid he in the firft act) that I with
> wings as fwift
> As meditation or the thoughts of love,
> May fweep to my revenge.

His fervent defire now therefore, was, that HORATIO, who knew all, might furvive him, not merely to reveal the murder of his father, but to make known to all men the infinite indignation which this excited in him, and the plan of vengeance which he had laid. HORATIO, for this purpofe, would defcribe the two great and leading features in the character of HAMLET, pointed out by the finger of SHAKESPEARE himfelf, that "noble heart," and that "fweetnefs," with which at once he was diftinguifhed. Upon the latter of thefe two, HORATIO would particularly explain the fcheme of counterfeiting madnefs, which that fweetnefs had fuggefted; and which, at the fame time, would fave HAMLET from paffing for a real madman in the opinion of pofterity.

As

As certain critics, however, have thought, ſome, that there is an incongruity, others, that there is an immorality, in the character of this perſonage, it becomes a duty in the charitable to juſtify the poet, and to revive the office of HORATIO, in the defence of his hero.

To underſtand the character of HAMLET, we had beſt perhaps take it at two different times, before the death of his father, and after that period; for while the ſubſtance is in both the ſame, the form is exceedingly different.

THE former of theſe, and which was his radical and general character, was a compound of many particular qualities; an exceeding high elevation of ſoul, an exquiſite ſenſibility to virtue and vice, and an extreme gentleneſs of ſpirit and ſweetneſs of diſpoſition. With theſe were conjoined the moſt brilliant and cultivated talents, an imagination tranſcendently vivid and ſtrong, together with what may be called, rather an *intuition*, than an acquired knowledge of mankind. And there may be added ſtill, a ſingular gaiety of ſpirits, which hardly at any after period, the very gloomieſt only excepted, ſeems to have failed him.

THESE being the fundamental properties of HAMLET, we have only to ſee what effects would be produced upon *ſuch* a man, by the villany of his uncle, the murder of his father, the inceſt of his mother, and the ghoſt of his father calling upon him for revenge. Theſe were the dreadful ſprings which put HAMLET into motion; and in which ſtate, SHAKESPEARE brings him upon the ſtage.

I SHOULD venture to imagine, (both from the nature of a character ſo extenſive, and from the various motives to action) that SHAKESPEARE had no particular plan laid out in his mind for HAMLET to walk by, but rather meant to *follow* him; and, like an hiſtorian, with fidelity to record, how a perſon, ſo ſingularly and marvellouſly made up, ſhould act; or rather, (to uſe the

the term employed by the king) to deſcribe the "transformation" which he ſhould undergo. For this purpoſe, he kept an attentive and an undeviating eye upon HAMLET's previous and general character, (ſuch as he had figured it to be) without any intention to add a ſingle new feature, but only to take in ſuch new aſpects of it, ſuch new exertions of his powers, and ſuch new ſchemes of conduct, as ſhould naturally flow from his new ſituations.

THIS being ſuppoſed, the new colours under which HAMLET appears will be found entirely conſiſtent with the old, and ſpringing lineally from them; an indignation and ſenſibility irritated to extreme; the deepeſt anguiſh; at times a mortal melancholy; a counterfeited madneſs, in order to wait for opportunities of revenge; and a degree of real phrenzy, to which he ſeems, more than once, to have been actually driven by the ſtrength of his feelings, through force of which he was ſometimes upon the point of betraying his own ſecret. Still, however, there was neither violence, nor ſorrow, nor melancholy, nor madneſs, in the original and natural ſtate of his mind.

WHAT ſeems to explain the whole of HAMLET's conduct is the latitude of his character. He was at once a poliſhed gentleman, a ſoldier, a ſcholar and a philoſopher; as in the exclamation of OPHELIA:

> O what a noble mind is here o'erthrown!
> The courtier's, ſoldier's, ſcholar's, eye, tongue, ſword.

At one time, mild, courteous and contemplative; at another, animated with the keeneſt feelings; upon occaſions, all wrath and fire; looking down, at all times, as if from a ſuperior orb, upon whatever was little, inſincere or baſe among men.

Now,

Now, in ſuch an aſſemblage of qualities, combining to form the broad character of HAMLET, SHAKESPEARE appears to have ſeen, that they were balanced in ſuch an oppoſite manner, that one claſs of them ſhould counteract, and render inefficient the other. It is this that ſuffered nothing to be done; it is this that conſtantly impeded the action, and kept the cataſtrophe back. Reſentment, revenge, eternal indignation, ſtimulated HAMLET at one moment; at the next, we have the mere unbending and recoil of theſe paſſions; and not only this, which was tranſient, but there followed, almoſt at the ſame inſtant, that gentleneſs which ſo ſeldom left him. From this, he could not, at any time, act in cold blood; he could ſtrike only in the fierceſt moments of provocation; then "could he "drink hot blood!" In the general tenor of his mind he could do nothing; he was like SAMSON, when his ſtrength was gone from him.

MEANWHILE, he is almoſt conſtantly chiding himſelf for *dull mettle, dull revenge, want of gall;* a ſelf-reproach which, in ſome ſcenes, breaks vividly out; as upon the occaſions where he ſaw a mere player weeping over HECUBA, and when he was told that the delicate prince FORTINBRAS was marching at the head of his troops to riſk his life for an "egg-ſhell." HAMLET, in ſhort, was not formed for action. Upon the fluctuation of his mind between contriving and executing, between elevation, ſenſibility and gentleneſs, hangs the whole buſineſs of the tragedy.

IN ſuch a ſtate of HAMLET's frame, the project of counterfeiting madneſs occurred to him with great conſiſtency. It was a device to which his nature led; bent upon vengeance; deſtitute of reſolution directly to gratify it; aſſuming therefore the cloak of inſanity, in order to lull ſuſpicion, and to watch at leiſure for thoſe occurrences which time or chance might preſent. To ſecure, by this fiction, his perſonal ſafety was, in

no

no degree, his view; for "he did not ſet his life at a pin's fee;" but, by means of his life being preſerved, to embrace the opportunities of revenge. It was from the ſame ſoftneſs in his nature, that he afterwards ſtrove to make himſelf believe, that his father's ghoſt might be the devil trying to "abuſe him;" and which ſuggeſted to him the ſtratagem of getting a play to be performed before the king.

HIS anxious adherence to the project of counterfeiting madneſs, to which he made every thing elſe give way, explains his *rudeneſs*, as Dr JOHNSON calls it, to OPHELIA; for to deceive the beloved OPHELIA into a belief of his madneſs, and to inſult *her*, was the ſureſt of all means to make it believed that he was really mad. And this alſo accounts for his making her brother LAERTES believe, that the rough treatment he gave him at his ſiſter's funeral, proceeded not from love to OPHELIA, its true cauſe, but from diſtraction; and which is ridiculouſly called by Dr JOHNSON, a "falſehood unſuitable to the character of a good or a brave man." HAMLET was then in the very preſence of the uſurper, and, on that account, induſtriouſly "proclaimed," that what he had done, proceeded from madneſs.

CONNECTED with this point, it has been thought vain by ſome critics *, to juſtify SHAKESPEARE in his making HAMLET forget (as they think) OPHELIA ſo ſoon after her death; inſtead of which, he ſhould have waited, they ſay, for the effect which time has upon the change of feeling; and Dr JOHNSON has remarked that "time toiled after him in vain." But I ſhould apprehend that this is entirely to miſtake the character. Time toils after every great man, as well as after SHAKESPEARE. The workings of an ordinary mind keep pace indeed with time; they move no faſter; they have their beginning, their middle, and their end; but ſuperior natures can reduce theſe into a point. They do not indeed ſuppreſs them; but they ſuſpend, or they lock

* Mirror, &c.

them up in the breaſt. It is the very mark and prerogative of a great ſoul, upon great occaſions to outrun time, to ſtart at once, without ſenſible tranſition, into another period. Even a common ſoldier, in the heat of action, were his deareſt companion to fall by his ſide, would not (although he could) drop his arms and mourn over him. In a ſimilar ſtate, but infinitely more interesting, was HAMLET at this time. And if doubts ſhould ſtill be entertained about the exiſtence of HAMLET's love to OPHELIA after her death, the queſtion can be brought to the ſhorteſt iſſue. HAMLET himſelf will anſwer, That his love for OPHELIA was greater than ever. When LAERTES, half-delirious himſelf with grief for his ſiſter's madneſs and death, leaped into her grave, and imprecated "ten times triple woe upon the "curſed head of him (HAMLET) who had deprived her of her "moſt ingenious ſenſe;" HAMLET burſt upon him at once from his concealment, like thunder from a cloud;

What is he whoſe griefs
Bear ſuch an emphaſis? whoſe phraſe of ſorrow
Conjures the wand'ring ſtars, and makes them ſtand
Like wonder-wounded hearers? This is I,
HAMLET the Dane— [*leaps into the grave.*
Why, I will fight with him upon this theme
Until my eye-lids will no longer wag.
I loved OPHELIA; forty thouſand brothers
Could not, with all their quantity of love,
Make up my ſum. What wilt thou do for her?
—— Come, ſhew me what thou'lt do.
Woo't weep? woo't fight? woo't faſt? woo't tear thyſelf?
Woo't drink up Eiſel, eat a crocodile?
I'll do't—Doſt thou come hither but to whine?
To out-face me with leaping in her grave?
Be buried quick with her, and ſo will I.
&c.

His

His love had been only the deeper embofomed; it had become too facred to be feen; and like fire, when pent up, it had acquired greater force.

THERE feems alfo to be a miftake in the attempt which fome * have made, in juftification of SHAKESPEARE, to reconcile the melancholy to the jocularity of HAMLET. For his jocularity, I fhould rather conceive, fprung more from the elevated than from the melancholy parts of his nature. He was not, ftrictly fpeaking, a melancholy man; although it be true that, at times, he was plunged into a ftate of genuine and deep dejection. In fuch a ftate, and in certain kinds of it, we have heard of the *joy of grief*, and can underftand it—fomething fweetly grave and penfive; but the *gaiety* and *pleafantry* of grief are things which probably never exifted. It is, on the other hand, the exclufive act of a great mind, to make truce with forrow; to difmifs the deepeft anguifh; to put mirth in its ftead; and HAMLET, in fuch fcenes, was only for a little refuming his ftrength. Even the melancholy which is afcribed to him, and which indeed he afcribes to himfelf, was often not melancholy, but wild contemplation and reverie.

THERE are many fimilar inftances of the connection between elevation and pleafantry, both in the character of nations and of individuals. The Spaniards, for example, are defcribed to be of a grave and lofty fpirit; yet among no people is there more humour. Individuals of this caft are not unfrequently to be met with in every country. MOLIERE may be inftanced, who was one of the moft ferious and refpectable men that ever lived; and yet no writer has had fuch a propenfity to farce and buffoonery; his plays being in general juft the counter-parts of himfelf. It is upon fuch principles, I would venture to explain the pleafantries of HAMLET; in which he rofe up, at times,

 from

* Mirror.

from an abyſs of anguiſh, to make a mere ſport of human ſufferings.

THE cauſes of HAMLET's dilatory progreſs have been already pointed out in general; and the more narrowly we take a view of him, the more we ſhall always find his ſenſibility to be, in the firſt moments, ſuch, as led to inſtant and mortal action, while his gentleneſs, like an equal weight on the other ſide, counteracted its whole force. SHAKESPEARE has deſcribed him, in the cool ſtate of his mind, as averſe, and even ſhocked, at the thought of killing. His mother ſaid, that, in this ſtate, he was "as patient as the female dove." If we take his own account of himſelf, he was a coward:

—— Now, whether it be
Beſtial oblivion, or ſome craven ſcruple
Of thinking too preciſely on the event—
A thought which, quartered, hath but one part wiſdom,
And ever three parts, coward—I do not know,
Why yet I live to ſay, This thing's to do.

THERE was a ſuperſtition alſo in HAMLET, which prevented him from putting the uſurper to death, when in the act of prayer. For the reaſon he himſelf gave for deferring this, was, that if he killed the king in the midſt of his devotions, he would in fact be doing him a good ſervice, "ſending a "villain to heaven."

Why, this is hire and ſalary, not revenge.
He took my father groſsly, full of bread,
With all his crimes broad blown, as fluſh as May;
And how his audit ſtands, who knows ſave Heaven?

He put up his ſword, and waited till he ſhould find him engaged

gaged in drink, rage, inceſt, gaming, ſwearing, or other act that had " no reliſh of ſalvation in't;"

> Then trip him, that his heels may kick at Heaven,
> And that his ſoul may be as damn'd and black
> As hell, whereto it goes.

THE ſentiments in this laſt paſſage have been conſidered as the moſt difficult to be defended in the whole character of HAMLET. Without having recourſe to a defence of them upon the principle of retaliation, and other pleas, there ſeems to be ground for an explication of a very different nature, founded upon what appears to be the real character of this perſonage, and altogether exculpating him from the charge of thoſe horrid diſpoſitions which he has been ſuppoſed here to poſſeſs.

HAMLET, in theſe lines, (if it may be allowed to offer a conjecture) was really *impoſing* upon himſelf *; deviſing an excuſe for his averſion at bloodſhed, for his cowardice, his " craven " ſcruple." In the firſt moments, he propoſes inſtantly to ſtrike—" now I'll do't." His ordinary ſoftneſs immediately recurs; and he endeavours to hide it from himſelf, by projecting a more awful death at a future period, but which he ſeems never to have thought of afterwards, and which was not at all conſonant to his general character. Indeed, what the king himſelf ſaid of him afterwards, upon baſely propoſing to LAERTES to uſe " a ſword unbated," is a ſufficient proof that there was nothing dark or malignant in his nature.

> —— He being remiſs,
> Moſt generous, and free from *all* contriving,
> Will not peruſe the foils.

THE

* SINCE writing this Eſſay, I have the pleaſure to find, that the ſame idea has occurred to Mr Profeſſor RICHARDSON, in his additional obſervations on HAMLET; and which he has ſucceſsfully enlarged upon.

THE execution of his two ſchool-fellows, ROSENCRANTZ and GUILDENSTERN, in conſequence of an artifice which he contrived againſt them, has alſo drawn the cenſure of critics. But is there any evidence that HAMLET thought them unacquainted with the mandate which they carried for ſtriking off his head in England? Whether they were in fact privy or not privy to this, is not the queſtion. Did not HAMLET believe they were privy to it, and even were fond of it? "Whom I will truſt "(ſaid he early) as I will adders fanged." And ſpeaking afterwards to his confident HORATIO, he added,

> Why, man, they did make *love* to this employment;
> They are not near my conſcience.

That is, my conſcience does not upbraid me; the cruelty lies not with me, but with them. And in this conduct of HAMLET, to the companions of his early days, does SHAKESPEARE prove his ſkill in human nature; the ſtrongeſt hatred ſucceeding, upon ſuch occaſions, to the ſtrongeſt friendſhip: For that they were his ſchool-fellows, he would conſider, and with reaſon, as a great aggravation of their guilt.

IN all other reſpects, the character of HAMLET ſtands confeſſedly fair and great. He moved in the higheſt ſphere of men; poſſeſſed an elevated and comprehenſive mind; penetrated through every character; knew the whole of human life; ſaw nothing noble but virtue, nothing mean and baſe but folly and vice. Speaking to HORATIO,

> Since my dear ſoul (ſays he) was miſtreſs of her choice,
> And could of men diſtinguiſh, her election
> Hath ſealed thee for herſelf; for thou haſt been
> As one in ſuffering all, that ſuffers nothing;
> A man that fortune's buffets and rewards

Haſt

Haſt ta'en with equal thanks : and bleſt are thoſe
Whoſe blood and judgment are ſo well co-mingled
That they are not a pipe for fortune's finger,
To ſound what ſtops ſhe pleaſe. Give me that man
That is not paſſion's ſlave, and I will wear him
In my heart's core.

Men praiſe in others what they love and poſſeſs in themſelves; and HAMLET was here drawing ſome of the outlines of his own character.

To the principles of morality and a conſummate knowledge of mankind, he joined the accompliſhments of learning and the graces of life. His eloquence was ſuch as great orators only have poſſeſſed, rich, tropical, daring, ardent, vehement. The directions he gives to the players, are models of taſte and laws for the ſtage. His wit and fancy ſeem to have belonged only to himſelf. Even in his character of ſoldier and hero, and which I all along conſider as his weaker part, an intrepidity breaks forth at times beyond what is human; as appears in the ghoſt-ſcenes, where his courage grows with danger; where he is not only unterrified, but ſports with what appals the reſt of mankind.

THE HAMLET of SHAKESPEARE, taken all in all, ſeems thus to be the moſt ſplendid character of dramatic poetry; poſſeſſing, not one or two great qualities, the ordinary compaſs of the heroes in tragedy, of a LEAR, an OTHELLO, a RODRIGUE, an HORACE, but comprehending almoſt the whole of what is beautiful and grand.

THE miſtakes which critics ſeem to have fallen into, can be all traced perhaps to partial and ſide-views which they have taken of HAMLET; but which can neither explain his whole character, nor ſufficiently account for the intereſt which is excited.

SENSIBILITY,

SENSIBILITY, for example, making a ſtriking figure in this character, has been thought to be the ſole baſis of it, without conſidering that mere ſenſibility cannot excite a tragic intereſt; cannot attach; cannot overwhelm; and indeed ſeems unable to make any other impreſſion but that of pain, when viewed apart from the cauſe in which it acts, and from the other qualities with which it is conjoined. Neither can a SENSE OF VIRTUE be admitted as the only ruling principle; for even this does not ſufficiently account for the intereſt; and both ſyſtems fail in explaining the inefficiency of the character, which reſults from the ſoft and amiable, and hence, in a great degree, the intereſting parts of it. For in both, the gentleneſs of HAMLET, the great impediment to the action, has been overlooked; although, to ſupply its place, a weakneſs and irreſolution, ſometimes deduced from exceſſive ſenſibility, ſometimes from melancholy, are recurred to in the former, but which are certainly of a tranſient duration, while gentleneſs was a permanent quality; and, in the latter, while the ſame office is allotted to irreſolution, the irreſolution itſelf is deduced from the moral faculty, ſuſpending and abating reſentment; but which ſurely would ſuppoſe, what cannot be admitted, that the pious and noble revenge of HAMLET had ſomething morally blameable in its nature. Two elegant and ingenious publications are here alluded to *; but in both of them, the ground taken is, I humbly think, too narrow; and this ſeems to have been the cauſe, why recourſe has been had to refinements, in order to ſtretch it out. Facts certainly ſupply us here with two principles at leaſt, ſenſibility and gentleneſs; and there hence ſeems no neceſſity for reſolving the whole conduct of HAMLET into the former, as is done in one of theſe publications. Neither are we to recur, ſometimes to the

* THE one anonymous, in No. 99. and 100. of the *Mirror*; the other, the *Analyſis of* HAMLET, by Mr RICHARDSON.

the one principle, ſometimes to the other, taken ſeparately, in order to explain HAMLET. It is the *ſtruggle* between the two, upon which his conduct hinges. This appears in the very opening of the tragedy.

> The time is out of joint; Oh curſed ſpight!
> That ever *I* was born to ſet it right.

Here, ſenſibility and gentleneſs may be ſaid to ſpeak in one and the ſame breath; a proof that their operations were not ſucceſſive, but co-exiſtent; and reigned nearly equal in power in HAMLET's breaſt.

ELEVATION ſeems to have been nearly as much overlooked as gentleneſs. Yet between theſe two was HAMLET almoſt always moving. For his ſublimity of ſoul ſeems to have been the very ſpring which prompted and whetted his ſenſibility to the quick. SHAKESPEARE in one phraſe, " a noble heart," meant to expreſs both; as they were in fact intimately conjoined, and acted at once, together.

THERE is an impreſſion which great accompliſhments and ſplendid talents, independent of every thing elſe, eſpecially in a tragic cauſe, never fails to make upon mankind. Theſe ſhine moſt powerfully in the character before us; and probably have contributed much to the charm which has made audiences hang upon HAMLET. The world, for the firſt time, ſaw a *man of genius* upon the ſtage; and the intereſt which the ſpectators have taken, and perhaps for ever will take, receiving an addition from this cauſe, ariſes thus upon the whole, from the many different ſources which the poet, by a ſuperlative effort of talents and of ſkill, has combined together.

THE fault (if any) of the play ſeems to lie in this, that there is not the uſual intereſt excited in it, for the final event. What SHAKESPEARE's purpoſe in this reſpect originally was,

cannot be affirmed. It is poſſible, that, finding the character of HAMLET to grow upon him, he varied in the progreſs from what he had intended in the outſetting of the play, and giving to HAMLET, on this account, a fuller ſcope, (but without departing from the character) he eventually threw more intereſt into the perſon than into the plot. Whatever may have been the cauſe, we ſee the effect,—HAMLET, in his ſole perſon, predominating over, and almoſt eclipſing the whole action of the drama. It is he that draws the admiration; it is he that engroſſes the concern; all eyes are turned more and more to him; HAMLET is wiſhed for in every ſcene; king and queen, inceſt and murder, as objects of tragic attention, vaniſh almoſt away; the moment HAMLET's own fate arrives, the play is ended. The intereſt which the hearts of men take in the principal character of this tragedy, ſtands thus in competition with the laws of the drama; and it becomes a problem, which of the two, the means or the end, ſhould preponderate.

ON account of the intereſt being transferred from the action to the agent, the moral, taking the ſame courſe, is to be drawn rather from the particular conduct of HAMLET than from the general buſineſs of the play. But what that particular moral is, may be difficult to aſcertain. We may ſay, perhaps, that from the conduct of HAMLET, it appears, how unfit for the work of revenge are the qualities of a ſoldier and hero, when conjoined with thoſe of a ſcholar and philoſopher; yet we cannot preſume to affirm, that it was SHAKESPEARE's object merely to exemplify this, or even to conceive, that he limited himſelf to any ſingle object or moral. Thoſe things which ſeem to have been uppermoſt in his mind, and which he has made to ſhine with moſt light, are the charms in the perſonal character of HAMLET. Enamoured with theſe himſelf, it ſeems to have been his chief purpoſe to raiſe the ſame paſſion in his audiences. That he has intimated this, by his interpreter HORATIO, only in

in one or two lines at the close of the play, is to be ascribed to his judgment. The purpose which the dramatic poet has in view, is to be found out by the best of judges, the feelings of the spectators. From a superior skill upon this point, RACINE has merited the praises which have been given him, while, from a failure in it, the great CORNEILLE has been deservedly blamed.

END OF THE SECOND VOLUME.

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E R R A T A.

Phyf. Cl. page 10. *line* 14. *for* properly *read* improperly.

———— 131. *line* 5. *and* 4. *from the bottom, and alfo in the laft line, for* EY *and* EZ *read* E*y*, E*z*.

———— 134. *line* 5. *for* $8(AD^2+BD^2+CD^2)$ *read* $4(AD^2+BD^2+CD^2)$.

———— 159. *in the note, line* 1. *for* $\frac{m-n}{8}$ *read* $\frac{m-n}{9}$.

———— 204. *line* 5. *from the bottom, for* $(100)^2$ *read* $(10)^4$.

Lit. Cl. page 9. *line* 4. *for* vindicates *read* indicates.

[*Omitted in the Lift of Donations, page* 80.]

By *Mr Robert Kerr*, furgeon, Edinburgh.

Elements of Chemiftry, by *M. Lavoifier*, tranflated from the French. 8vo. 1790.

DIRECTIONS FOR THE BINDER OF VOL. II.

The Binder is defired to obferve, that the VOL. confifts of Three Sets of Pages, to be arranged in the following order, immediately after the TABLE of CONTENTS, *viz.* PART I. containing the HISTORY of the SOCIETY: PART II. containing, I. PAPERS of the PHYSICAL CLASS; II. PAPERS of the LITERARY CLASS: And that the Plates are to be placed as follows, *viz.* the Plate entitled *Quaffia Simaruba Mas*, facing page 82. *Phyf. Cl.* and *Quaffia Simaruba Feminea*, immediately after it; the Plate entitled *Craig-Phadrick*, facing page 32. *Lit. Cl.* and *Dun-jardel* immediately following; and the other five according to the references marked on them.